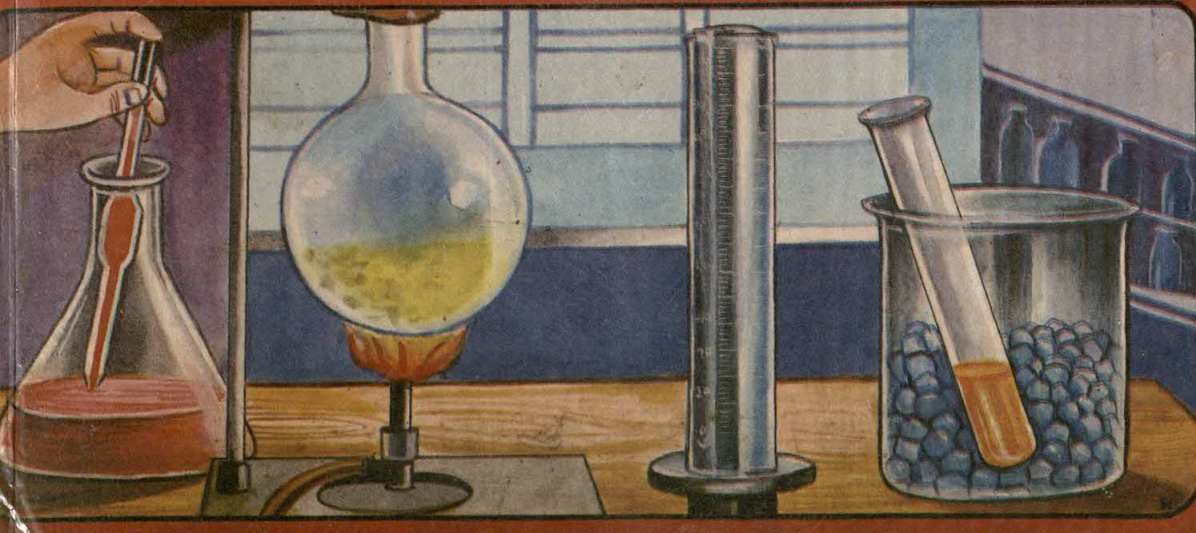
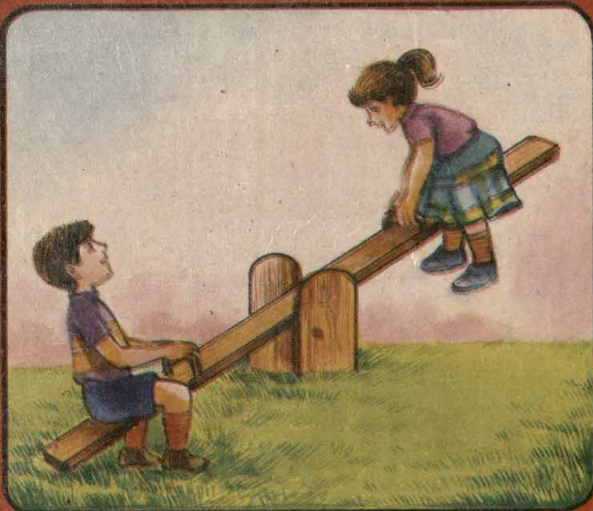
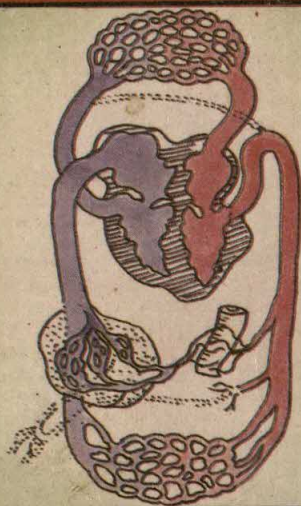


A CONCISE COURSE IN

SCIENCE

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BOOK I

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BOOK I

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BOOK I

(For Class VI)

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PREFACE TO THE FIRST EDITION

It is considered necessary to initiate a new approach to the study of Science at the school level. At present the emphasis in Science teaching is on the pupil making discoveries by investigation and on the understanding rather than on the memorization of facts.

The new approach to the study of Science demands the active participation of students in the learning process through experimentation. This approach leads to a proper understanding by the students of the basic concepts of Science and enables them to discover new ideas.

The efforts of the authors have been to relate, as far as possible, the teaching of Science to what a student sees and does in everyday life. The thrill and excitements of doing experiments help the students to understand the subject and find something new for himself. Students are curious; they search to understand the unknown and so an interest in learning develops. Efforts have been made here to involve the pupil, physically and emotionally, to make the learning of science a personal experience.

This series has been designed to meet these needs. It fully covers the latest syllabus in science prepared by N.C.E.R.T. under the New Education Policy. The language used is simple and concise. The text has been attractively illustrated with many clearly labelled diagrams. Carefully planned out questions are given in the text to teach the pupils to reason and to arrive at logical conclusions. A large number of *Objective type* and *Short answer questions* have been included to help the students in self testing. A number of new diagrams make the matter self explanatory. The experiments and activities have been carefully designed to fit naturally into their inquiry and are such that every teacher and student can perform without difficulty.

The authors would feel happy if this book could satisfy the needs of the students of the middle school classes and help them to understand and appreciate the applications of the fundamentals of Science in everyday life. Suggestions for improvement of this book would be gratefully accepted from fellow science teachers, students and parents.

—Authors

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SCIENCE IN EVERYDAY LIFE

I need not tell you that we are living in a world of Science. You need only to read a daily newspaper, listen to the radio, watch the television or the cinema and you will be amazed at the new words you come across everyday; such words as atomic energy; reactor; atomic bomb; artificial satellite; Insat-I; rockets; plutonium; radar; plastics; nylon; stainless steel; streptomycin; computer; laser and jet aeroplanes. Perhaps you do not know the meanings of all these words, but you have certainly met with many of them. These words tell you of the rapid way science is marching forward and entering into our daily lives.

It will be interesting to start your study of science by considering in more detail how science affects your daily life and why it is important for you to study science. Try to learn about the type of houses and the mode of travel and communications that prevailed say in 1905. You will find, since then, things have changed a lot. Everything has considerably improved such as the type of houses; modes of communication; medicines; entertainment; quality of clothes etc. It is through science and its application that such fast development and improvement have come about. Science helps us in acquiring new knowledge about things and happenings around us. It has improved our existing knowledge and devices. Through systematic approach and

hard work we can solve many problems. Scientific thinking helps us to invent new devices. In this unit you are going to see the various ways in which science and its methods have been of benefit to mankind and, simultaneously, why the study of science is important.

Science Helps

Try to think of the various ways in which Science has affected the life of man and write them down as they occur to you. You will no doubt cover several pages of your note book. While you examine your list you will probably find out that the various ways you have thought of can be arranged in groups and each group of the given a name. I am going to suggest some groups here, and you should try to see in which group you ought to include each of the ways you have written down.

(a) Science keeps you in good health

This is by far the most important benefit science has brought, for if we are not in good health we cannot really enjoy life. In years past several thousands of people died each year from diseases, the causes of which were not known. Now Science has discovered the causes of many diseases such as smallpox, tuberculosis, malaria and plague, and has found ways of preventing and of curing them. We do not even hear about smallpox or plague. The

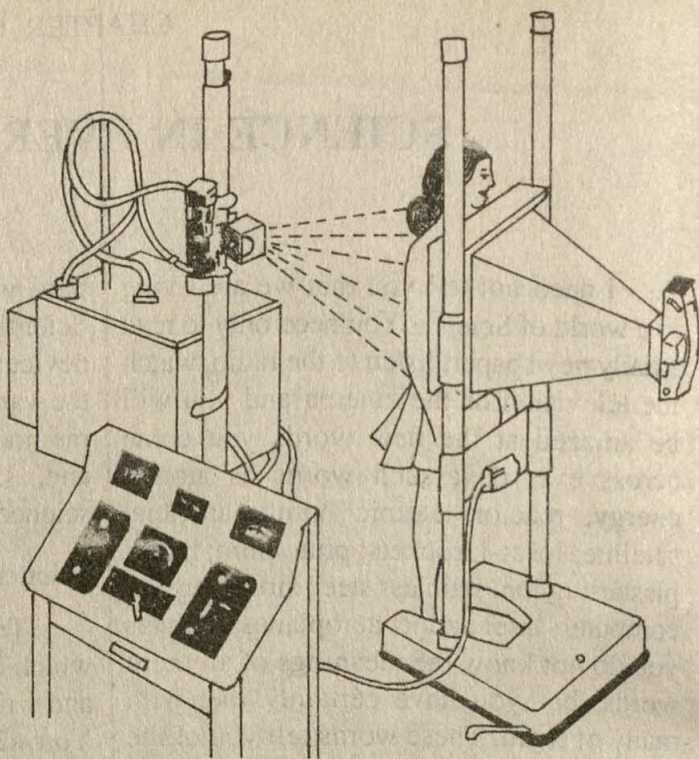


*Fig. 1.1 (a) Rontgen - inventor of the X- ray machine
(b) Use of X-ray machine to check a patient.*

fight against disease still continues; diseases such as cancer and paralysis are still being investigated. On the whole, medicines and vaccines protect us from many diseases. Science has increased our expectation of life; that is, the number of years we may expect to live.

(b) Science helps to produce the things you use

It is impossible to exhaust the list of things science has given us. I will just mention a few recent ones. Go round any market and examine the various articles being sold. Plastic is one thing that cannot escape your attention. Plastic plates; plastic cups; plastic spoons; plastic bags; plastic combs; plastic table cloths; plastic toys, plastic buckets; they all seem to meet your

eye wherever you go. only a few years ago plastics were practically unknown. Scientists have discovered how to manufacture them and to-day many useful articles are made of plastic.

Until a few years ago most of our clothing were made from natural fibres; wool was made from animals, cotton and linen from plants and silk from silk worms. To-day these fibres are still being used, but in addition we hear of newer materials such as nylon, orlon etc., all of which have been produced by the scientist from his test-tube. He has made rayon from wood pulp and nylon from coal, air and water. Such materials produced in the laboratory are known as synthetics. Synthetic rubber and stainless steel are another examples of this.



Fig. 1.2 Things made from plastic.

(c) Science makes work easier :

You need only to look around you to observe the various ways in which science has simplified work. A farmer now tries to save sufficient money to buy tractor to replace his ploughs; the housewife tries to save up for an electric or gas stove, an

electric washing machine, an electric iron, a vacuum cleaner and other electrical gadgets which would make her work easier; building contractors use pulleys and cranes and consult scientists for the correct mixture of building materials and similarly for paints; they also use bulldozers for clearing

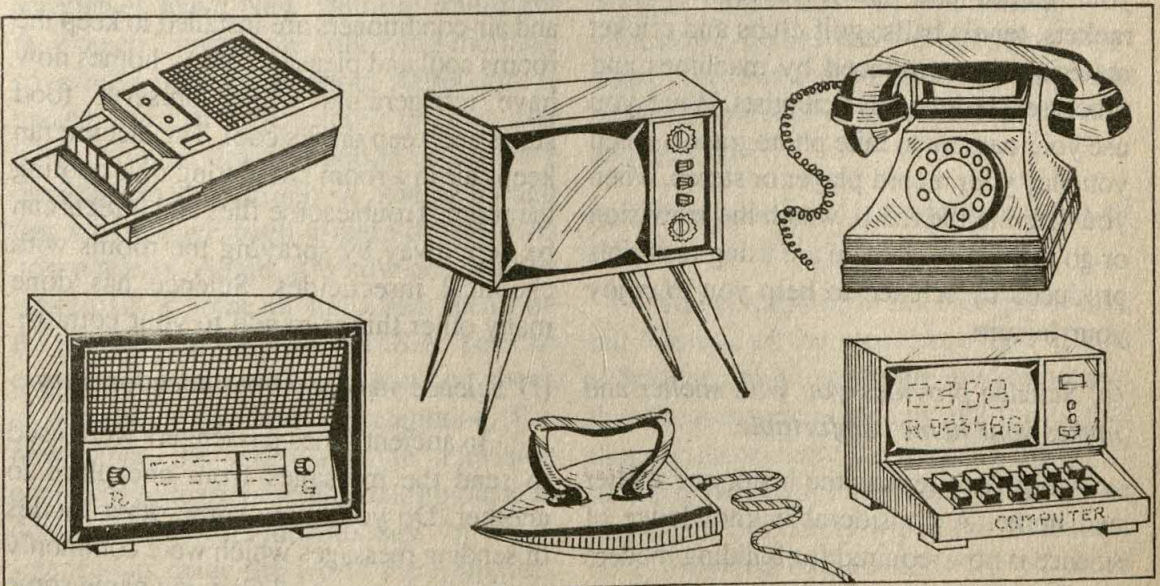


Fig. 1.3 Science helps in the enjoyment of leisure.

thick bushes and drilling machines for digging holes; lifts are now commonly used in tall buildings and escalators in the big

commercial houses. One could continue endlessly adding to this list, but it is better to stop here and leave you to think for more items.

(d) Science helps you to enjoy your leisure :

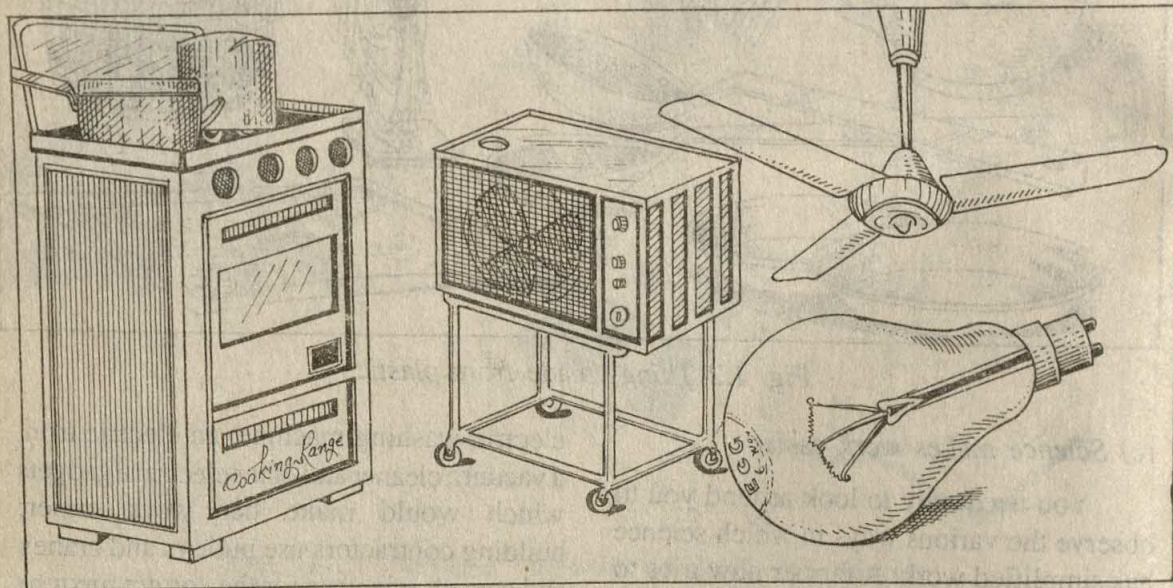


Fig. 1.4 Science has made our life comfortable.

Almost all the equipments you use in your games and sports footballs, tennis rackets, tennis balls; golf clubs and cricket materials, are produced by machines and processes designed by scientists. When you use your camera to take photographs, when you play your record player or stereo, when you listen to the radio, watch the television or go to the cinema, you are using materials produced by science to help you to enjoy your leisure.

(e) Science provides you with shelter and makes your home comfortable.

Fig. 1.5 depicts the history of shelter and home. A considerable knowledge of science is now required for building modern comfortable houses. Science has produced electricity to light our houses. Fluorescent

lights are almost like day light. In many offices and in some homes desert-coolers and air-conditioners are installed to keep the rooms cool and pleasant. Many homes now have refrigerators which preserve food stuffs and keep drinks cool. The electric fan keeps air in a room circulating thus cooling the room. Troublesome flies and insects can be kept away by spraying the rooms with chemical insecticides. Science has done many other things to add to your comfort.

(f) Science makes communication easy.

In ancient times passengers were used to send the messages from one place to another. Do you know some other modes of sending messages which were commonly used in earlier times? Can you name some other means of communication which we



Fig. 1.5 : Science provides comfort in the home

use these days ? The bullock-cart, the bicycle, the scooter, the motor-car, the train, the steamer, the aeroplane, the helicopter, the satellite, the newspaper, the radio, the television, telephone all have been designed by scientists to enable you to travel and to communicate more easily and quickly from place to place. When jet propelled aeroplanes leave New Delhi at mid-night they reach London the following morning covering a distance of about 10,000 km. It means you can have supper in India and lunch the next day in London taking only breakfast in the airliner. A few years ago this would have been a mere dream. It is now a reality. Again, it is now possible for you to sit at home in India and speak on the telephone to someone in U.S.A. You can even be in a ship on the ocean and speak to somebody on shore by telephone. The newspaper, the radio and the television enable us to learn of events taking place in distant lands from day to day. In short, science has made the world seem smaller. Insat-I, the communication satellite, now

enables some events occurring in Washington D.C. to be seen on television in India, and other countries. Interestingly it appears it is actually happening. It is even possible to see on a screen the person one is talking to another over the telephone. The fact that one could go round the whole earth fifteen or eighteen times a day travelling several hundreds of thousands of kilometres, makes the world appear tiny. There is no doubt whatever, that Science has made all forms of communication simpler and quicker.

(g) Science helps to change your ways of thinking

You perhaps have not thought of this, but it is one of the most important affects of Science. Primitive people used to believe that diseases were caused by evil spirits, that thunderstorms were the result of the anger of one of the gods. These superstitions have now been completely wiped out. Scientists have provided explanations for all these natural occurrence, and our ideas about

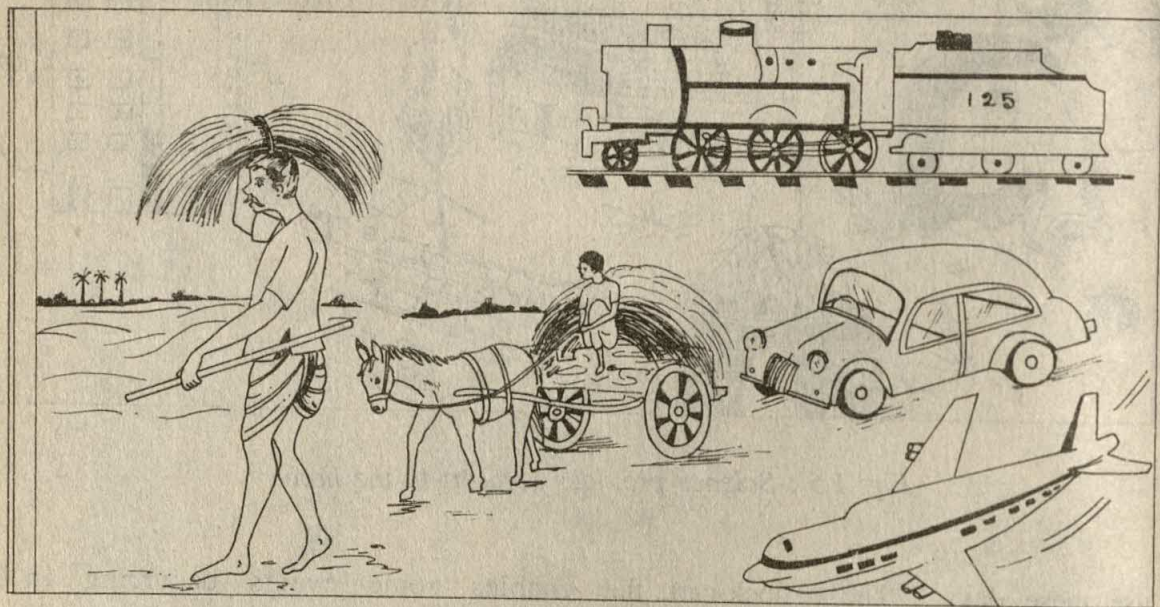


Fig. 1.6 : Science makes communication easy.

them have thus changed.

All the above mentioned developments have come through Science. It is necessary to keep in touch with these developments. People always try to get more knowledge and use it suitably. You, too, must be curious about many things. You also need to know more about things and happenings for better living. You can learn through books, magazines, radio and television and from elders. You get knowledge by observing things and events very keenly and asking the elders questions.

1.2 How Does a Scientist Work ?

The procedure which eminent scientists used to answer their problems has come to be known as the *scientific method* or the *method of problem-solving*. The life histories of these scientists reveal the brilliant way in which they arrived at their

scientific conclusions. Sir Humphry Davy's discovery of the safety lamp, Louis Pasteur's discovery of the prevention of the disease known as hydrophobia and Galileo's discovery of the pendulum provide good examples of the scientific method.

Scientific methods are used by us in cooking and other household activities. A farmer working in the field and a potter making earthen pots also use scientific method. Even when you notice that your lock in the door at home is stuck and does not get opened by turning its key in it, you use a scientific method to detect the cause and repair the fault. First you try to find out which part, like the lever or the key is not functioning well. Then you check carefully and try to find the exact part that does not work. You observe the faulty part keenly and decide why it is not functioning. You then decide what needs to be done.

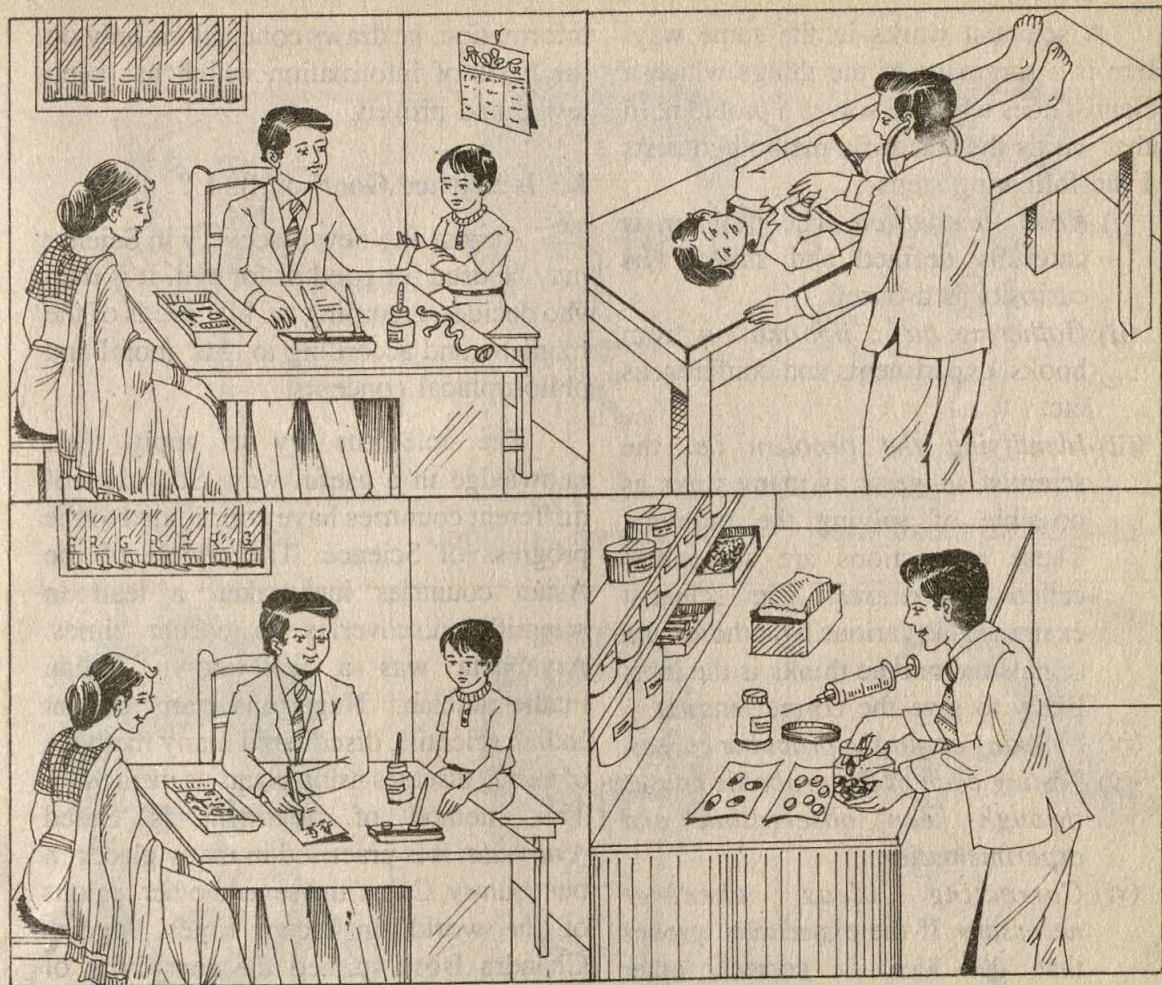


Fig. 1.7 A doctor is a scientist

Accordingly you readjust the part, oil it or decide to replace it.

Let us take another example of a doctor. A doctor is a scientist and observe keenly how he works.

- (a) The doctor gathers information by asking you questions. How long have you been suffering ? Where do you feel the pain ? Is the pain acute or mild ?
- (b) The doctor examines the different parts of your body.
- (c) The doctor measures, pulse rate, blood pressure, temperature etc.

- (d) The doctor records these observations and keep them in mind.
- (e) The doctor analyses the possible reasons of the sickness and makes certain assumptions.
- (f) The doctor prescribes or gives appropriate medicines on the basis of his assumptions.
- (g) The doctor then confirms his assumptions by conducting tests of blood, stool, urine and screening through X-rays.
- (h) The doctor finally decides the course of treatment according to the results.

A scientist works in the same way. Here is a summary of the things which a scientist does when he solves a problem. In other words the scientific method consists of the following steps :

- (i) *Keen observation.* The problem is carefully defined and stated. His curiosity is aroused.
- (ii) *Gathering basic information* from books, experiments and conferences etc.
- (iii) *Identifying the problem i.e.,* the scientist suggests as many ways as possible of solving the problem. These suggestions are sometimes called *hypotheses*. The scientist examines his various hypotheses and selects the one he thinks is the most likely to give the correct answer.
- (iv) *Thinking about the probable causes.*
- (v) *Testing each of the probable causes through keen observation and experimentation.*
- (vi) *Correcting ideas whenever necessary.* If the experiment proves that the idea is correct, other experiments may be planned to test it further and verify it. If the experiment does not prove the hypotheses that idea is put aside and a new one is selected for testing.
- (vii) After testing the idea that has been proved correct by the experiment, the scientist is ready to draw his conclusion.
- (viii) Finally, his conclusions are published to make available for readers.

You will notice that the procedure demands from the scientist a great deal of self-discipline, honesty and perseverance. He has to use all his senses in collecting

information; he draws conclusions only on the basis of information which has been tested and proved.

1.3 Is Science Good or Bad ?

Almost any new discovery in Science may be used for good or for evil. It is man who decides, according to his needs of the moment, and according to his moral and philosophical concepts.

The scientists try to apply their knowledge in a useful way. Scientists of different countries have contributed to the progress of Science. The people of the Asian countries had taken a lead in scientific discoveries in earlier times. Aryabhata was a well-known Indian mathematician. Nagarjuna, an ancient Indian scientist, discovered many methods of curing diseases using plants as medicines. This method of treatment is called *Ayurveda*. It is practised in many places in our country, China and several other regions of the world. In recent times, Jagdish Chandra Bose studied the sensitivity of plants in detail. The hard and valuable work of scientists such as Sir C.V. Raman, S. Ramanujan, S.N. Bose, M.N. Saha, D.N. Wadia, B. Sahani, P. Maheshwari, G.N. Ramachandran, T.R. Sheshadri, Homi Bhabha and Vikram Sarabhai has helped our country to progress in many fields. At present there are a large number of scientists in India helping significantly in the growth of Science and the development of the country.

A scientist named Edward Jenner worked very hard and found out a vaccine to protect people from getting some diseases. This vaccine protected many people against diseases all over the world.



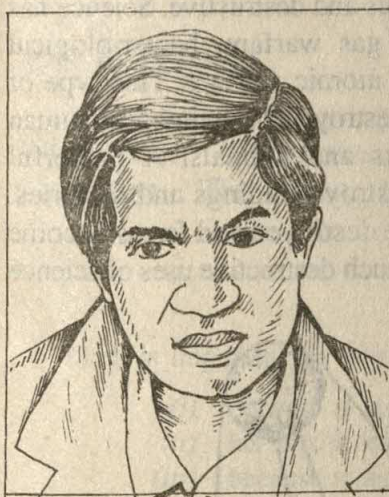
C.V. Raman



Jagdish Chandra Bose



Homi Jehangir Bhabha



S. Ramanujan



S.N. Bose



H.N. Saha

Fig. 1.8 Some famous Indian scientists

Similarly, Alexander Fleming discovered a very effective medicine called *penicillin*. Penicillin has cured many people from various infectious diseases. You must have heard of Madame Marie Curie, a Polish scientist. She worked very hard and invented radium and polonium. One scientist, Leeuwenhoek prepared a microscope and observed many tiny things, not visible by naked eyes. Microscopes

proved useful in studying different types of germs, examining the blood, and so on. Methods to preserve milk, jam, etc., were found out by Louis Pasteur. These methods are being used by food industries.

Science has invented many things. Some of the latest triumphs of science are really wonderful. They are quite remarkable discoveries. The triumphs of science are too many to be counted. Science has helped to

solve many of our problems like food, health and transport. Pumps and canals provide us more water for irrigation. Better seeds, fertilizers and insecticides are available now. You can save crops from many diseases. Inspite of that many people do not get enough and proper food. The invention of wonderful drugs like penicillin, streptomycin and chloromycin has conquered the world of death and disease but medicines for certain diseases such as cancer are yet to be discovered. Industries help us produce more commodities. At the same time, however, some waste materials like smoke and some chemicals are produced. Some of these make air and water impure. They harm plants, people and animals. How to minimize these effects ? Answers to such questions need to be found out through scientific investigations and applications.

The invention of rockets and sputniks

has amazed mankind. The rockets and sputniks have reached other planets. These inventions have made space-travel easy.

While the latest triumphs of Science have revolutionised mankind on the peaceful aspects, its triumphs in the event of war are no less amazing. Once people learnt that certain substances explode easily, they made bullets, bombs, crackers, etc. These were devised for our safety and security. Some people misused bullets to kill animals in the forests and to commit dacoities. The existence of some beautiful animals and birds is in danger. Science has made war very dangerous and destructive. Science has given to us gas warfare, bacteriological warfare and atomic warfare. This type of warfare can destroy and kill innocent human beings, plants and animals. A powerful bomb can destroy buildings and factories. The crops are destroyed and farms become infertile. All such destructive uses of science

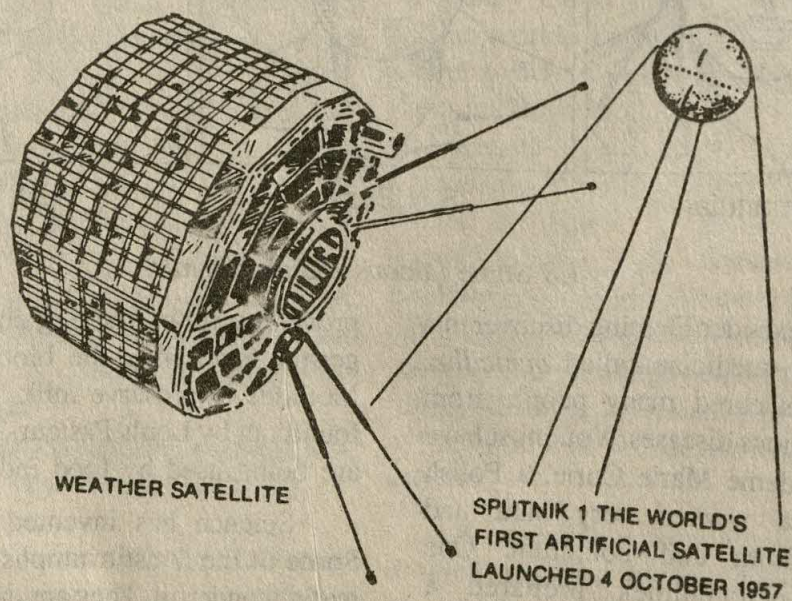


Fig. 1.9 (a) Uses of Science.

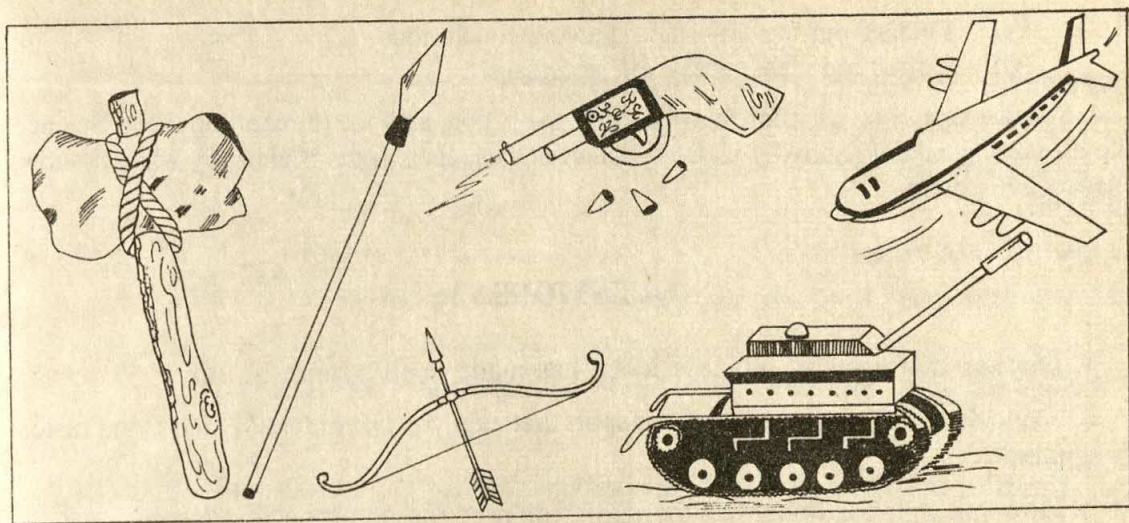


Fig. 1.9 (b) Abuses of Science.

must be avoided.

Thus Science has progressed in both the aspects, constructive as well as destructive. The latest triumphs and

victories of science need to be properly applied, otherwise they will bring death and destruction for mankind if these inventions and discoveries are misused.

SUMMARY

1. It is important for you to study science for many reasons, some of which are :

- (i) because it keeps you in good health;
- (ii) because it helps to produce things you use;
- (iii) because it makes work easier for you;
- (iv) because it helps you to enjoy your leisure;
- (v) because it makes you feel comfortable in your house;
- (vi) because it makes communications easy;
- (vii) because it helps you to change your ways of thinking;
- (viii) because it shows you the scientific method of solving problems.

2. Reading, listening to elders, observing keenly and clearing your doubts by consulting experts are the ways of acquiring knowledge.

3. The scientific method consists of the following steps:

- (i) Observation
- (ii) Gathering basic information
- (iii) Identifying the problem
- (iv) Thinking about the probable causes
- (v) Testing each of the probable causes through keen observation and experimentation.

- (vi) Finding out the result and drawing conclusions
- (vii) Correcting ideas, whenever, necessary.

4. Science should be used for the welfare of the people and not for harming them. Science, while it makes mankind happy by its latest achievements, also makes it unhappy when it shows its destructive power.

QUESTIONS

1. Discuss two ways in which science has made people more healthy.
2. Name three different modes of transport that help you travel fast. Which is the fastest among them ?
3. How has Science improved the distribution of the common things we use ?
4. State five ways in which you think Science has made our lives more comfortable.
5. How has Science made our world look smaller ?
6. How has Science proved advantageous with regard to the following :

Writing	Typing
Cycle	Car
Hand fan	Ceiling fan
Man carrying message	Telephone
Drawing water from a well	Hand pump
Plough	Tractor
Hand stitching	Sewing-machine
Cotton clothes	Nylon clothes
7. Name two scientists and mention their contributions to Science.
8. Mention three advantages and two disadvantages of factories.
9. Name a device by which you can see things which are
 - (a) far away
 - (b) very very small
10. How can you make yourself audible in a large gathering ?
11. What is meant by the scientific method ? Outline the various steps a scientist follows in solving a problem.
12. Many people argue that science has made the world a more dangerous place to live in because accidents and deaths due to moving vehicles (cars, lorries, planes, etc.) increase every year. Put up an argument against this belief.
13. How will you find out whether the water available in your locality is fit for drinking or not ?

14. Fill in the following blanks :

- (i) Science helps us in acquiring knowledge about things and around us.
- (ii) One gets knowledge by things and events very keenly and asking the questions.
- (iii) A doctor is a and observe how he works ?
- (iv) The method of curing diseases using plants as medicines is called
- (v) Alexander Fleming discovered a very effective medicine called

15. Name the Indian scientist who studied the sensitivity of plants in detail.

16. Match the following :

Scientist	Radium
Communication	mode of sending messages
Television	Thinks over the observations and possibilities
Madame Curie	celebrations in countries overseas
X-Rays	reconnect cut nerves
Laser beams	produce shadow of bones.

ACTIVITIES

1. You are given sand and soil, separately. You are also given some gram seeds. You have to find out whether sand or soil is more suitable for seed growth. Note the information in your note book. What method would you follow to find it out ?

2. Ask a gardener or a farmer about how he selects the seeds. Note the information in your note book.

3. Take four different types of seeds such as gram, bean, moong and peanut. Find out the proper conditions for seed germination. Set up an experiment. Observe the seeds every day. Note down your observations and explain the following :

(a) Do all seeds germinate at the same time ?

(b) Is the growth rate the same in all seeds ?

CHAPTER II

THINGS AROUND US

There is such a variety of materials existing on earth, that the scientist has to look for ways of arranging these materials into sets. The scientific word for material is *matter*, the ways in which matter behaves are known as the *properties of matter*.

2.1 Material Around us

You are reading this book made of paper while sitting in a chair made of wood, in the light coming through a glass window. Your food is packed in glass, metal, paper or plastic containers. Hundreds of different materials are part of your way of living. Select almost any object, and you will find that usually it can be formed from a choice of different materials. For instance, a drinking tumbler can be made of glass, porcelain or plastic. And it is just as true that any chosen material can be formed into many different articles. From a glass we can make a drinking tumbler, window pane, camera lens or lamp bulb. Similarly a block of wood can be carved into the shape of a doll or a boat; yet we see that it is still a piece of wood.

Activity (1)

Take two glass beakers, fill one of them with water and now observe which one is heavier ? The one which contains water—the heaviness is due to the amount

of the water or *mass* of the water in the beaker.

Activity (2)

Take two balloons, blow air into one of the balloon. Suspend the balance. From the other and suspend an empty balloon. You will find that the beam tilts down towards the inflated balloon. This shows that *air has mass*.

Activity (3)

Take a balloon and blow air into it. You will see that the air makes the balloon take up more space.

Anything that has mass and occupies space is called matter.

2.2 Different States of Matter—Solids, Liquids and Gases

Everything in the world is either a *Solid*, a *Gas* or a *Liquid*. All solids, gases and liquids are made up of tiny pieces of matter called *Particles*.

These particles vibrate—that is they move backward and forward at a very great speed.

In solids, they vibrate in fixed positions.

In liquids and gases they are not fixed



Fig. 2.1 Three states of matter

to one spot and can move about. This allows the whole thing they are part of to flow. For this reason, liquids and gases are both called *fluids* (things that flow).

But liquids and gases are quite different from each other.

In *gases*, the particles do not attract each other very much, so they move about freely and tend to spread out as widely as possible. The space occupied by a gas changes easily.

In *liquids*, the particles are more strongly attracted to one another. The particles move about less freely than in gases.

So liquids, unlike gases, take up a definite space. Particles near the surface of a liquid are attracted to all the other particles, which means that they cannot easily break away.

2.3 Distinction between types of matter

How can these three states of matter be distinguished from each other? The most common liquid matter on earth's surface — water will help to answer these questions.

We say that water is a liquid because that is what it is at normal, every day temperature. But above its boiling point it turns into steam — which is a gas. Below its freezing point, it turns into ice — which is a solid.

Gases can be turned into liquids by cooling them to a temperature below their boiling point. Steam will change to water when it touches a cold window.

Solids can be turned into liquids by heating them until they melt. Ice melts at 0°C (32°F). That is why water is liquid at normal temperatures.

2.4 Properties

(a) We can keep a solid but cannot keep a liquid or a gas. So all liquids and gases *flow* but solids do not.

(b) When we put sugar cubes or salt in water what happens? It disappears into the water. Similarly when we open a bottle of perfume it disappears into the air. So liquids and gases can act as *solvent* into which other substances (solute) disappears.

out which of the above object *floats* and which one *sinks*.

Objects that float are *lighter* than water. Those *sink* are *heavier* than water. Substances like water, glass etc., through which light can pass easily and we can see across the things easily are called *transparent*. Through which light cannot pass and we can not see are called *opaque*. Such as wood, iron sheets etc.

Substances which can be beaten into thin sheets without breaking are called *Malleable* such as Gold, Silver etc. Substances which can be drawn into their wires are called *Ductile*. Fine ductile metal is Platinum.

2.6 Elements

Elements are simple substances. They make up everything in the world—ourselves included. Of the 105 known elements, some, such as iron and copper, have been used by man since ancient times, others such as lawrencium and mandeleivium are man-made. They do not occur in nature

Substances such as, water and sugar decompose giving simple substances—Oxygen, Hydrogen and Carbon, which cannot be further divided. Such simple pure substances are known as *elements*. Robert Boyle defined an element thus — *An element is a substance which cannot be broken down further into other substances.*

Oxygen, copper, iron etc., are simple substances or elements. Molecules of oxygen consist of identical atoms of oxygen only. Therefore, an element can also be

defined in the following way.

"Simple substances, which are made up of only one kind of atoms are called chemical elements."

As all written material in English has only 26 letters of alphabet, all the words and sentences that go into producing such a variety of literature are obtained by using different combinations of these 26 letters.

2.7 Compound

Chemist John Dalton decided to find out how much of each element is needed to form its compounds. He experimented with many combinations and found that he could always mix a couple of elements in any amount, but if he wanted to form an actual *compound* of the two, they had to be used only in a certain proportion.

For example — water, which is a compound of oxygen and hydrogen whenever chemists want to combine these two elements to form water, they find they must use them in a certain *proportion*, which is always the same, no matter whether they are forming a single drop of water or many gallons. They find that each atom of oxygen must hold on to two atoms of hydrogen.

'These atoms join up to form one molecule of water'. (H_2O) "Substances that consist of two or more than two elements combined together are called *Compound*."

2.8 Atoms and Molecules make up, elements and compounds

All elements are made up of tiny particles called *atoms*. Atoms consist of even smaller *subatomic* particles.

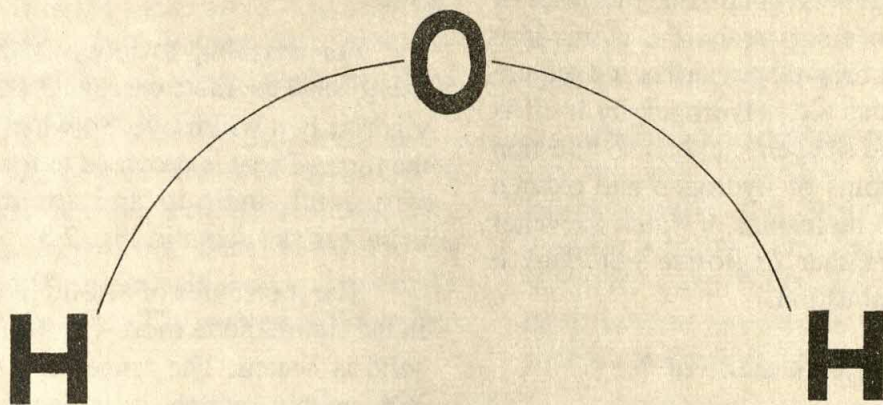


Fig. 2.6 A molecule of water.

Atom

Since ancient times, learned men or philosophers have thought about matter and what it is made up of. It was believed that matter was made up of very tiny particles which were too small to be seen. These particles were so small that they could never be further divided into smaller particles. They gave the name particles, the name *atoms*, which means 'those which cannot be divided'. The difference between the various kinds of atoms and the ways in which they were joined were supposed to result in the different kinds of matter.

A piece of iron is made of iron atoms, a piece of silver is made of silver atoms.

All atoms of any one element are alike but atoms of one element differ from the atoms of another.

Quite often, atoms of the same element or of different elements come together and get attached to each other. This attachment produces a new particle called a *molecule*.

For example, two oxygen atoms react to produce one oxygen molecule.

Now take an example of a molecule made up of atoms of different elements.

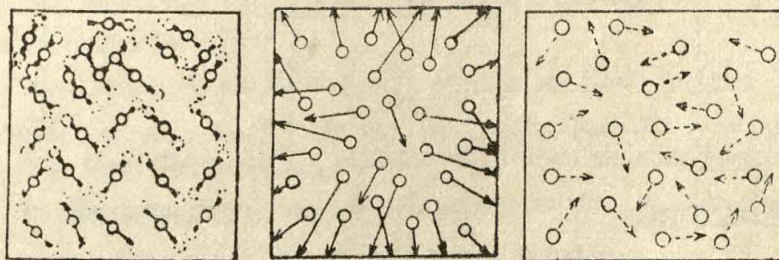


Fig. 2.7 Molecules

When two atoms of hydrogen react with one atom of oxygen we obtain one molecule of water. When atoms react, the atoms lose some of their original properties and acquire new properties e.g., Hydrogen by itself is explosive and oxygen supports combustion but when atoms of hydrogen and oxygen react to form molecules of water, the water formed is neither explosive nor does it support combustion.

What are objects made of ?

All objects are made of one material or another. All materials in the universe are made up of elements and compounds. Atoms combine and produce molecules.

When atoms and molecules are simply packed together, there is no reaction occurring between them. Such materials are called *Mixtures*. Air is a mixture of oxygen, nitrogen and several other gases.

In a mixture, the constituents may be present in any proportion but compounds are formed from elements by chemical combination in definite proportion only.

Molecular range increases on heating a solid

For anything to move it must have energy, and the more energy it has, the more vigorously it will move. So when energy in the form of heat is provided to the molecule of a solid, their to and fro movement increases as shown in Fig. 2.8.

The molecules of a solid like A, B, C in the figure move more vigorously as the solid is heated. The range represented by XY, within which a molecule like B vibrates, increases as the solid is heated.

As the heating continues the motion becomes so violent that the molecules no longer remain in their restricted position but wander around more freely. The substance has now become a liquid. If the heating is continued, the molecules move more and more vigorously till they no longer stay together at all but fly off in all directions and the substance now becomes a gas.

2.9 Waste Products

When we use materials and objects

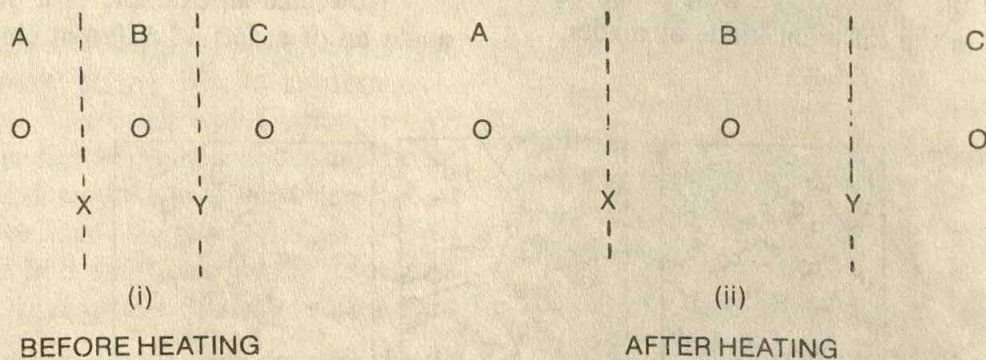


Fig. 2.8 Molecules of three solids A, B, C
(i) Before heating, (ii) After heating.

there are often waste products, *e.g.*, when we use coal the ashes are left behind. Old newspapers, empty bottles, torn clothes are other examples of waste products. What should we do with them ?

Some of these waste products can be used again and this is called *recycling*. Even the gas bags from ones home can be recycled if we put it in a pit and cover the pit with the earth. The garbage will turn into good manure.

Some factories release their smoke into the air. This makes the air unsuitable for breathing.

Therefore release of waste into air, water, and ground is called *pollution of the environment*. Such pollution is harmful and we must do our best to prevent it.

2.10 How should we choose materials and objects for everyday use

(a) What we choose must be suitable

for our need. We cannot choose brass vessel to store curd or buttermilk. Some materials dissolve a little bit of the brass and the material is bad for health when eaten.

(b) We should choose materials which are not very expensive and are easily available nearby. It is good to choose bricks to build a house where bricks are cheap. Similarly some fruits and vegetables are cheap in some seasons. During this time we should eat these fruits and vegetables.

(c) Materials and objects that are convenient to use should be preferred to those that break or wear out easily.

(d) We should try to use cloth woven on handlooms, as a large number of people make living out of it. If we all were to use mill-made cloth or synthetic, our weavers will earn no money.

We should carefully ensure that the advantages are more than the disadvantages before deciding to use a particular material.

SUMMARY

1. There are many materials and objects which are :

(i) Natural, (ii) Man-made, (iii) Living, (iv) Non-living, (v) Visible, (vi) Not visible, (vii) Able to flow, (viii) Not able to flow, (ix) Transparent, (x) Opaque, (xi) Solid, (xii) Liquid, (xiii) Gases, (xiv) Heavenly bodies.

2. Any thing which has mass and occupies space is called matter.

3. There are three states of matter :

(a) **Solids** – Definite shape and volume; molecules are closely packed.

(b) **Liquids** – Do not have fixed shape. They take the shape of the container in which they are kept. Their volume does not change and particles are loosely packed.

(c) **Gases** – Do not have a fixed shape and volume and their particles are far apart.

4. There are properties stated by all objects and materials.

5. Materials can be classified on the basis of some of their characteristics, such as solubility, heaviness or lightness, transparency, opaqueness, malleability or ductility. An element is made up of only one kind of atom.

6. Scientists have always been discovering and inventing new materials and these discoveries have been important steps in the progress of man.

7. Atoms combine to produce molecules.

8. The molecules of water, sodium chloride etc., are made up of different types of atoms. Such substances are called compounds.

9. When atoms and molecules are simply packed together and no reaction occurs between them; they are called mixtures.

10. All the molecules of an element or a compound are identical but the molecules of different elements and compounds are different.

11. Intermingling of molecules of one substance with those of another substance is called Diffusion.

12. We should never waste materials but recycle it.

13. We can prevent pollution of environment.

QUESTIONS

1. What is matter ?

2. What distinguishes a solid from a liquid ? A liquid from a gas ?

3. Name three substances you have met outside the laboratory which can be made to change its state. Explain what has to be done to each other to make it change the state, and name the change of state concerned.

4. Is hydrogen a gas, solid or a liquid ?

(i) What is the form of oxygen ?

(ii) Does the water have the properties of the two gases ?

5. What is an element ? Name any two elements.

6. What is a compound ? Name any two compounds.

7. What is a mixture ? Name any two mixtures.

8. What is pollution and how can we prevent it ?

9. Collect as many objects as possible and group them in any manner you like. Find out the advantages and disadvantages of each method.

10. How should we choose materials and objects for everyday use ?

11. Which of the following substances are elements, which are compounds and which are mixtures :

Water, Zinc, Sugar, Ice-cream, Mercury, Sodium chloride, Hydrogen, Air, Iron, Rust, Aluminium, Copper Sulphate, Oxygen.

12. Name two substances which are : 1. soluble in water, and 2. insoluble in water.

13. Fill in the blanks :

- (i) Anything which has and is called a Matter.
- (ii) There are states of Matter and
- (iii) All substances are made up of
- (iv) The process by which steam changes into water is called
- (v) The process by which water changes into steam is called
- (vi) A molecule of a compound consists of the of two or more.....
- (vii) A molecule of an element consists of atom of element.
- (viii) An element is made up of only one kind of
- (ix) Garbage from our homes can be and made in this way is called
- (x) Pollution of the environment means

14. Tick (✓) the correct statements and cross (×) the wrong one :

- (i) A gas is a substance that can be stored in a closed container. ()
- (ii) A liquid has a definite shape but has no definite volume. ()
- (iii) Substances that consist of two or more elements combined together are called compounds. ()
- (iv) Iron sulphide is an element. ()
- (v) Matter can be changed from one state to another. ()

ACTIVITIES

- 1. Make the balance to show that air has weight. The teacher will show you how to do this experiment.
- 2. Use clay to make a model of any object you like.
- 3. Find out the thickness of one sheet of your book.
- 4. Demonstrate that 'Air occupies space'. The teacher will show you how to do the experiment.

CHAPTER III

SEPARATION OF SUBSTANCES

3.1 Observations of separation of substances relative densities or specific gravity.

We come across many substances in our daily life. But they are mostly mixtures of different pure substances.

The atmosphere contains mixture of gases. Around industrial areas, the air gets polluted by the very small smoke particles and harmful gases coming out of the chimneys.

Most of the familiar materials around us are mixtures of compounds. Milk, wood, orange juice, paper etc., are all mixtures of this kind. Sea water is a mixture of several compounds all dissolved in the water. Soil is a mixture of a great many compounds. Air happens to be a mixture made up almost entirely of elements mostly oxygen and nitrogen. Brass is also a mixture of elements mainly copper and zinc.

We can have some objects like soap, hair oil, directly. To many others we have to do something before we can use them.

We filter tea to separate the tea-leaves before drinking. We pick out the stones from rice, pulses or wheat grains before cooking. You may also wish to remove sugar or salt dissolved in water.

Pure substances have definite physical properties. For example, they have fixed boiling point, melting point, or definite

For example, at sea level, pure water freezes at 0°C and boils at 100°C , but natural water which contains impurities, does not freeze and boil at 0°C and 100°C respectively.

Separation of the components of a mixture is done for various purposes — to remove impurities or to remove undesirable components etc.

The method of separation depends upon the characteristic property of the substances to be separated.

There are many methods for separating the particles. Now you will study some methods commonly used for separating the components of a mixture.

3.2 Sedimentation and Decantation

How can we separate a mixture of sand and water ?

Take some muddy water in a beaker and allow it to stand undisturbed for some-time. We notice that the suspended clay and sand particles settle down at the bottom. This method of allowing suspended particles to settle is called '*sedimentation*'.

The clean liquid above the sediment is poured off gently into another vessel as shown in the Fig. 3.1. This process of

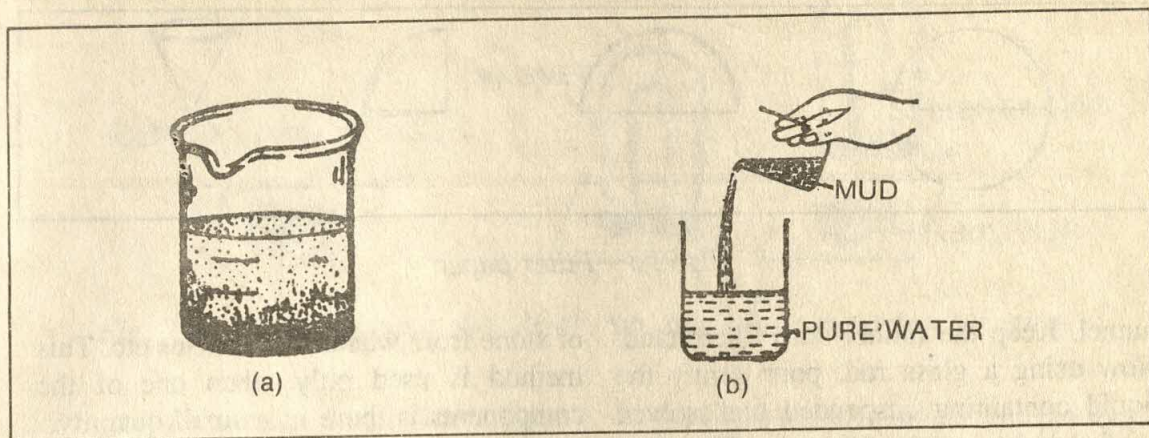


Fig. 3.1 (a) Sedimentation (b) Decantation

separating a clean liquid from the solid sediment is known as 'decantation'.

through filter paper. The solid particles are left behind on the filter paper.

3.3 Loading

In the rainy season sometimes very fine dust particles get mixed with the river or pond water. It would take a very very long time for the fine dust particles to settle down. So to increase the rate of sedimentation we can add some alum. The dissolving particles of alum load the fine dust particles.

We often sprinkle water before sweeping a dusty room. Here also we are using water to load the dust particles.

3.4 Filtration

We can separate a mixture of solid particles and a liquid in many other ways. A filter is an obstacle consisting of holes. Objects bigger than the holes in the filter cannot pass through it and, thus, are separated.

Filtration is a process of separating very fine undissolved solid particles present in a liquid by allowing the liquid to pass

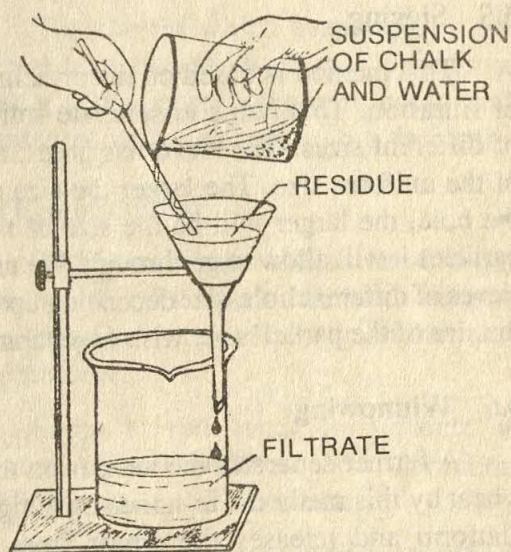


Fig. 3.2 Filtration

Many substances such as sand, cotton, glass, etc., can be used as filters.

Take a circular filter paper, fold it twice and make a cone as shown in Fig. 3.3.

Fit this filter paper into the funnel. Moisten the filter paper by adding one or two drops of water to make it stick to the

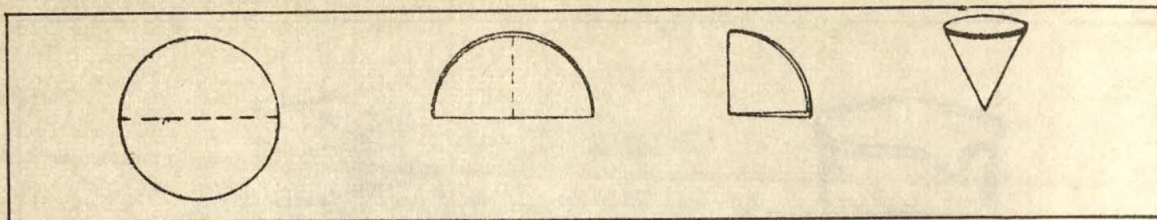


Fig. 3.3 Filter paper

funnel. Keep the funnel on a filter stand. Now using a glass rod, pour gently the liquid containing suspended undissolved solid particles into the filter cone. The clean liquid (filtrate) passes through the filter paper, leaving behind the fine undissolved particles, called the *residue*, on the filter paper.

3.5 Sieving

This method is based on the principle of filtration. This helps to separate solids of different sizes. The sieve has holes, all of the uniform size. The larger the size of the hole, the larger will be the size of the particles it will allow to go through. We use sieves of different hole-size depending upon the size of the particles we wish to separate.

3.6 Winnowing

A farmer separates the husk from the wheat by this method. He stands on a high platform and releases the wheat from a winnow. The wind has a very little effect on the wheat grains because they are heavy. The husk being light is blown away from the wheat by the wind.

3.7 Handpicking

It is usually done to separate undesirable substances such as small pieces

of stone from wheat, rice, pulses etc. This method is used only when one of the components is there in a small quantity.



Fig. 3.4 Winnowing.

3.8 Separation by a Magnet

If iron filings are mixed with some powdered sulphur, we can use a magnet to pick out the iron filings (Fig. 3.4)

3.9 Evaporation and Crystallisation

The separation is accomplished by

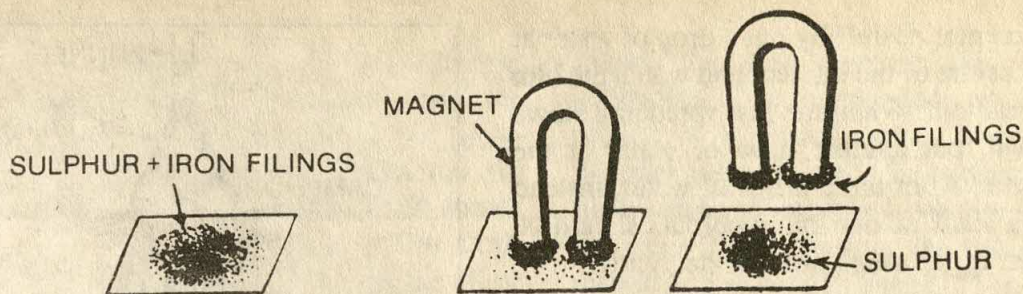


Fig. 3.5 Iron present in a mixture of iron sulphur is attracted by a magnet.

driving off the solvent. Heating the solution causes the water to evaporate and the solute remains behind (small crystals).

Take a few drops of salty water in a dish and leave the dish in the sun. You will see that the water has evaporated (gone away) leaving behind some solid on the dish and this solid is common salt which we wanted to separate.

This process is used to obtain salt from sea water.

Salt from sea water

We can easily obtain large crystals from some solutions. Dissolve as much alum you can in a cup of water. If you heat the water a little, you will find that you can dissolve more alum in it. When no more alum dissolves in it, filter the solution while it is hot. Take the solution in another cup. Suspend the thread in a cup and leave the solution uncovered and undisturbed. In a day or two, you will find a crystal growing at the tip of the string. The crystal will become bigger every day.

3.10 Distillation

The process of filtration, followed by evaporation separates a soluble solid from

an insoluble one and shows how the solute can be obtained from a solution. If the solvent is required, distillation must be performed.

In evaporation, the liquid solvent is lost. In distillation we get back the solvent.

The solvent which evaporates is not allowed to escape. It passes through a Liebig's condenser where it cools and condenses and then runs into a receiver.

3.11 Sublimation

There are some solids that change directly to gas upon heating, without becoming liquid; example—camphor and naphthalene.

Suppose you want to separate a mixture of salt and camphor. Camphor sublimates while salt does not.

Camphor on heating in an evaporating dish gives out white fumes directly. These vapours will condense as fine crystals on the cooler side of the funnel as the sublimate.

3.12 Chromatography

Place a piece of filter paper on top of a beaker and put one drop of black ink in

the centre. Carefully put a drop of water at the centre of the ink blot and watch the blot spread out. When the fast spreading slows down, put another drop of water at the centre. After three drops of water, instead of a black colour, other colours should be seen in the rings around the centre.

This method of separation is known as *Chromatography*.

3.13 The Principle

All methods of separation are based on just one principle, different materials have different properties and we can use this difference in properties to separate materials.

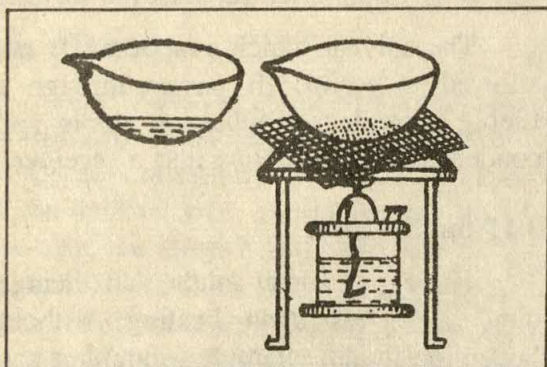


Fig. 3.6 Evaporation and Crystallisation

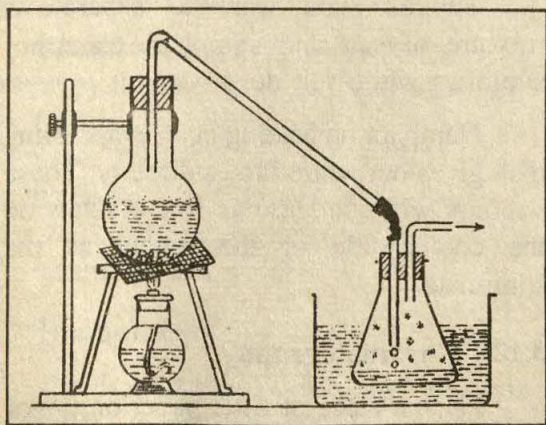


Fig. 3.7 The process of Distillation

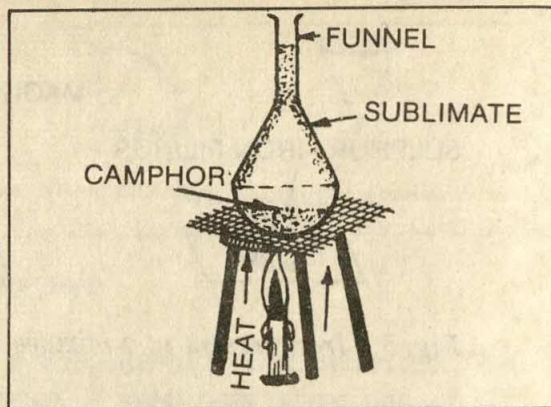


Fig. 3.8 Sublimation

3.14 Separation of immiscible liquids

Pour some mustard oil in water. The two liquids do not mix but separate into two distinct portions. The mustard oil is lighter than water and forms the upper layer. Such liquids are called *immiscible liquids* and can be separated by separating funnel.

The mixture of mustard oil and water is poured into the separating funnel, the stop

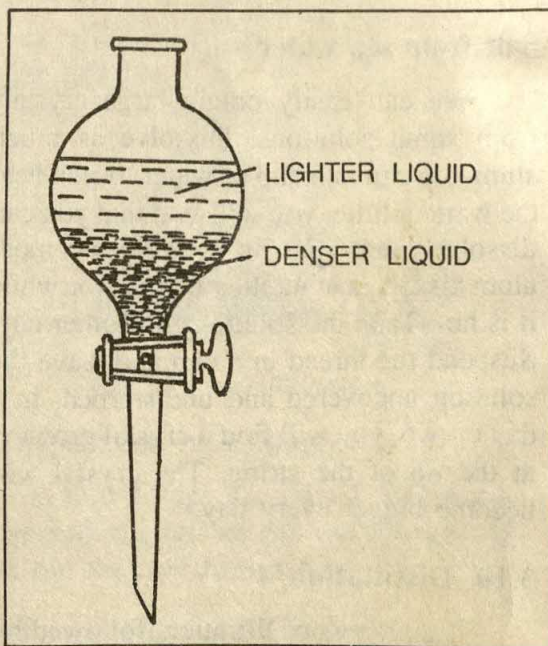


Fig. 3.9 Diagram of separation of liquid

cock is closed. Now gently open the stop cock. Oil being lighter than water forms the upper layer and water forms the lower layer. Allow the water to run out till the bottom of the mustard oil layer comes to the level of the stop cock. A few drops of water may be left behind with the oil or little oil may go through into the beaker.

3.15 Centrifugation

This is a method for separating the suspended particles of a substance in a

liquid. In this method the mixture containing fine suspended particles is rotated in a closed bottle. The heavier material moves towards the bottom and the lighter material remains at the top. It would be better if the bottle or the container is rotated at a very high speed. This process is used in milk dairies to separate cream from milk. Milk is rotated at a very fast speed in a closed container. Cream collects in the centre and being lighter than milk, floats at the top of the mixture.

SUMMARY

1. Pure substances have definite physical properties.
2. Pure substances have fixed melting and boiling point.
3. The method of separation depends upon the characteristic property of the substances to be separated.
4. We use different methods of separating substances, for example, (i) Sedimentation, (ii) Decantation, (iii) Loading, (iv) Filtration, (v) Sieving, (vi) Winnowing, (vii) Handpicking, (viii) By magnet, (ix) Evaporation and Crystallisation, (x) Distillation, (xi) Sublimation, (xii) Chromatography, (xiii) Centrifugation.
5. We can separate immiscible liquids by separating funnel.
6. All methods of separation are based on just one principle. Different materials have different properties and we can use this difference in properties to separate materials.

QUESTIONS

1. How would you separate the mixture of (a) sand and water, (b) wheat grains, dust and water? Describe the various steps involved.
2. How can we remove the harmful part of a mixture?
3. What does the filtrate consists of when (a) salt solution, (b) muddy water is filtered? What does the distillate consist of when sugar solution is distilled?
4. Why does alcohol separate first from a mixture of water and alcohol by distillation?
5. Impurities in substances are not always harmful. Why?
6. Why do you find water droplets on the outer surface of the glass full of cold water?
7. Differentiate the following :
(a) Decantation and Loading

(b) Sieving and Filtration

8. Only name the methods for separating the components of the following mixtures :

- (a) Salt and water
- (b) Oil and water
- (c) Iron filings and sulphur
- (d) Muddy water (to separate mud from water)
- (e) Salt and camphor
- (f) Cream from milk

9. Fill in the blanks with suitable words :

- (i) The process of changing water into water vapour is called
- (ii) The process of separating liquids from a mixture is called
- (iii) The process of separating a mixture of heavy and light materials is called
- (iv) A mixture of camphor and salt can be separated by
- (v) A process of is used by farmers for separating from the
- (vi) Pure crystals of copper sulphate are obtained by
- (vii) Two immiscible liquids are separated by using
- (viii) Both evaporation and condensation are involved in
- (ix) A substance is made up of only of molecules.
- (x) Cream is separated from milk by

10. Some statements are given below. Mark (✓) if the statement is true and mark (×) if it is false :

- (a) Our body does not have an ability to separate gases from the air we breathe in ()
- (b) Plants can absorb all the material from the soil. ()
- (c) Decantation can be used for separating two liquids such as oil and water. ()
- (d) Sulphur is separated from iron filings by loading. ()
- (e) Chromatography is used for separating the different coloured components present in a sample of coloured solution. ()

ACTIVITIES

1. Suppose the rice you buy from the market contains a lot of husk, dust and moth-eaten rice. How will you remove these undesirable impurities ?
2. Take a glass of water from the pond, or from the river and purify this water.
3. Suggest some methods of separating iron nails from small pebbles.
4. Try to separate salt from a solution of common salt in water.
5. Separate mustard oil and water from their mixture.

MEASUREMENT

4.1 Observation of Different Types of Measurements in daily life

(i) You know that when you go to buy a new pair of shoes, the first thing you do is to have your foot measured. A pair of shoes may look attractive but they are of little use to you unless they fit.

(ii) When a bus, a train or an aeroplane travels between two places, it is necessary to know the distance between these places. One reason for this is that the cost of sending the materials depends on the distance travelled. Can you suggest other reasons why the distance should be known?

(iii) In every day life, we often feel a

need to measure length. It may be when you want to get your clothes stitched at the tailor's shop (Fig. 4.2) or when you want to prepare the ground for playing football, hockey, kabaddi, or when you want a chair to be made by a carpenter. Perhaps you can give a few more examples.

(iv) If you have been to a railway station or an airport, you would have observed that passengers have to weigh their luggage. One reason for doing this is that there is a limit to the load which either a train or an aeroplane can safely carry. Suggest another reason why the loads to be sent out are weighed.

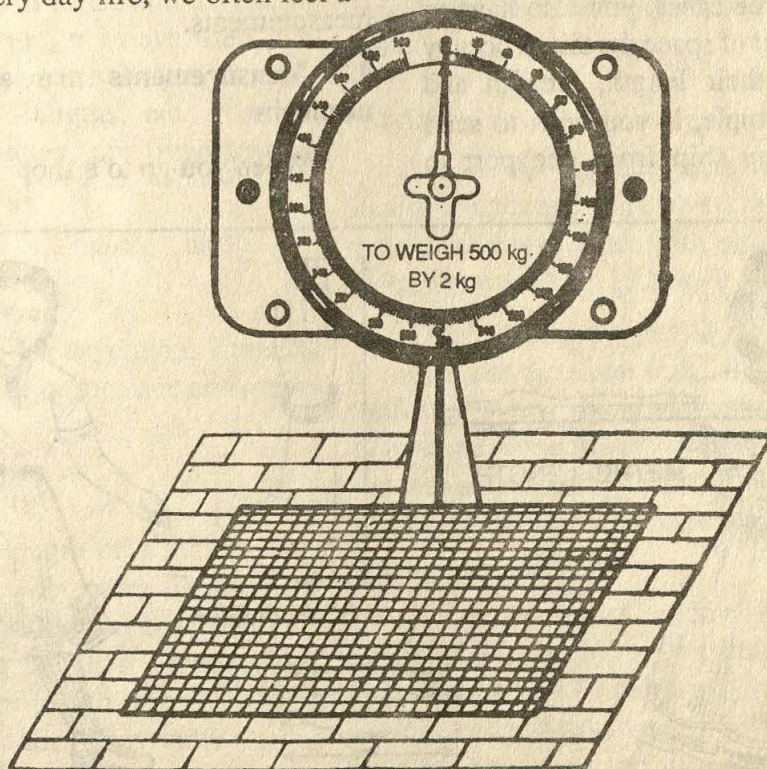


Fig. 4.1

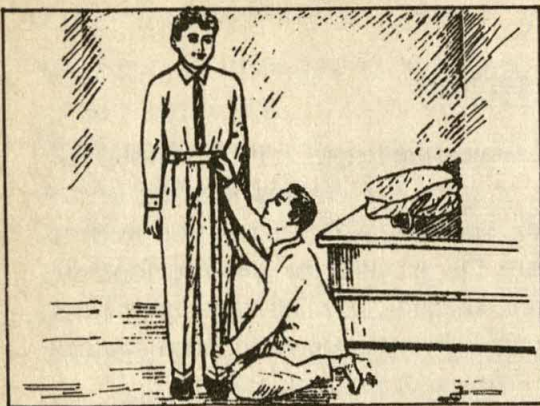


Fig. 4.2

(v) You have probably watched your mother weighing flour, rice and sugar to make cake – or perhaps measuring them by cupfuls.

(vi) When you buy sweets or toffees you would like to see if the shopkeeper is giving you the correct weight.

(vii) In some cases, you also have to know the amount of space the things occupy by measuring their length, breadth and height. For example, if you wish to send your luggage by ship from one port to

another, the cost of shipping depends on the space occupied.

(viii) You would like to learn to see the time and know how long it takes you to reach home from school.

(ix) You would like to know how hot or how cold it is on a day. You would also like to find out how much rain has fallen on a day or during a month.

Thus we have seen that we need to measure many things (living and non-living) in our daily life. We need to measure length, distance, weight, time, temperature, volume, area, rainfall, etc.

Activity

Observe the measurements which your father, mother and other people around you make and then prepare a list of these measurements.

4.2 Measurements are expressed in numbers

When you go to a shop to buy a piece

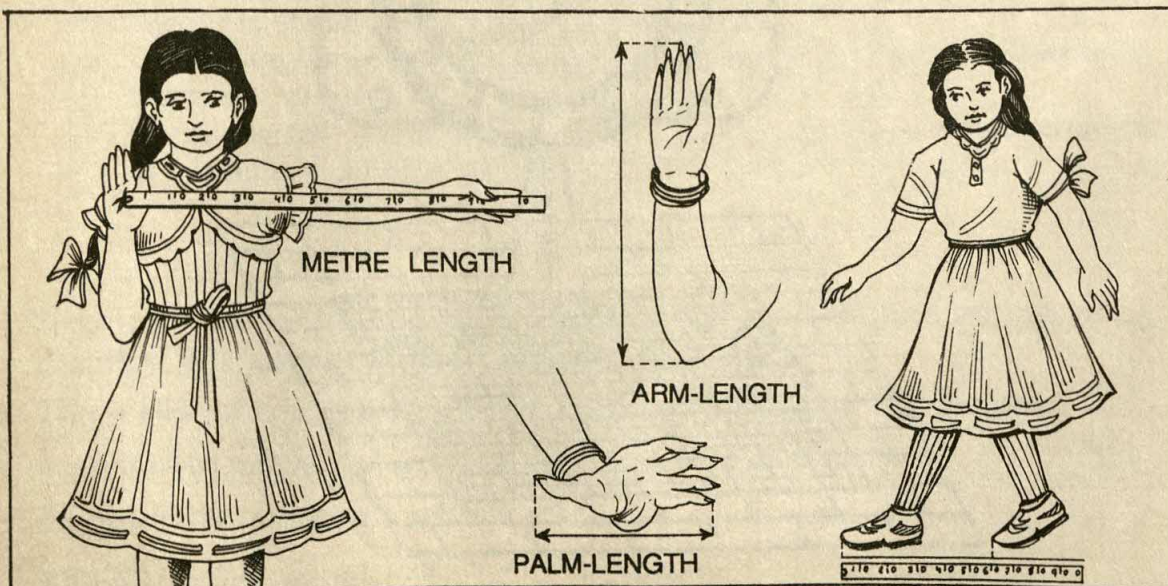


Fig. 4.3

of cloth for your shirt, you ask the shopkeeper to give you two-metre length of cloth. You know how he measured the cloth with a metre rod and then cut it. You have perhaps seen at home that the cloth is sometimes measured by using arm's length. If you do that, you may find that the cloth is five *arm-lengths*. You could also measure the cloth using your palm stretched out from thumb to little finger. Using your palm, you may find that the same cloth is ten *palm-lengths*. In all these ways of measuring we have compared the length of the cloth with a known length such as a metre, an arm-length or a palm-length. Indeed any *measurement means the comparison of the unknown length (i.e., the length you want to measure, such as piece of cloth) with the known length* such as a metre, an arm-length or a palm-length. In the above expression, we have used two quantities *e.g.*, two-metre length, 5 arm-lengths, 10 palm-lengths, etc. In other words, the quantities are representing following two things

- (1) a *measure* or a *number*, and
- (2) a *unit*.

When we say that the cloth is 2 metres long, 2 is the number or measure and metre is the unit.

Activity

Measure the length of a shawl using a metre scale and your palm. From these two measurements find out the length of your palm in terms of a metre. Now measure your palm-length directly with a scale and compare the two results.

From the above activity we get an idea of how many palm-lengths are equal to one

metre. We see from this example as well as from various other examples in daily life that measurements are expressed in numbers. The smaller the unit, the greater is the number or larger is the measure. One chooses a scale according to convenience. For example, if you want to measure the distance between two villages, what scale would you use ? Your palm-length ? Your arm-length ? Your foot ? Your steps ? A thread ? A metre ? A kilometre ? Think about this and give the reason for your choice of the scale.

4.3 Need of Standard Units

We have seen that we can express the length of a cloth as 5 palm-lengths, 3 arm-lengths, etc. Now, if your friend measured the same cloth with his palm or with his arm, would the measurements be exactly the same ?

Activity

Measure along the wall a distance of 10 arm-lengths and mark it. Ask your friend to measure this distance with his arm. Does he measure exactly 10 arm-lengths ?

Different scales give different answers. If you all use the same scale, it will not be confusing at all. *Metre* has been accepted all over the world as the standard of length. It is thus a *common scale* and is of the same length everywhere and for everyone. It is called a *standard scale*.

Let us consider another example. Suppose your uncle at Calcutta writes to you that he needs 10 palm-lengths of cloth for his shirt and asks you to buy the cloth for him. You go to the shop, and ask the shopkeeper to give you 10 palm-lengths of

cloth. The shopkeeper will immediately ask you, "whose palm-length" ? If you buy according to your palm-length, the cloth would be insufficient. It is again confusing : Why ? Because each one of you is using a different scale. If you all use the same scale, it will not be confusing at all. Different scales give different answers. Would it not have been better if your uncle had written that he needed 3-metre length of cloth ? Then there would have been no difficulty. Therefore a metre is a *common scale* and is of the same length everywhere and for every one. Such a Common Scale that remains the same, no matter when and by whom it is used is called a *standard scale*.

This standard can be any length, say the distance between two marks on a stick or the length of a rod, if all the persons in all the countries accept it. As a matter of fact, the distance between two marks on a platinum-iridium bar kept at the International Bureau of Weights and Measures in the French town of Severs near Paris has been accepted as the Standard of length, *The distance between two marks on this rod is defined as the 'metre'*. In our country we have decided to use the metre as the Standard Scale for measuring length. A copy of the International Standard of length is kept at the National Physical Laboratory, New Delhi. This serves as the national standard of length and all the scales manufactured in the country can be checked against this standard. Many countries in the world now use the metre as the standard scale for length. Such a widely used Standard Scale is known as a *Unit*.

The unit which people agree to use as a basic unit of measurement becomes a

standard unit for that group of people.

Just as we have metre as the Standard Unit of length, we also have standard units for *mass* and *time*.

The Standard Unit for length is a *metre* (*m*). The Standard Unit for mass is a *kilogram* (*kg*). The Standard Unit for time is a *second* (*s*).

This system of units (metre, kilogram, second) is called the *S.I. System*

4.4 Basic Units or Standard Units

To measure each physical quantity in Physics (for example, distance, weight, time, area, volume, etc.), we need a separate unit. This means that we should have as many units as the number of physical quantities. It shall be a difficult job to remember all these units. To make the measurement easier, we take a few quantities in physics as *basic* or *fundamental* quantities and we call their units of measurement as *basic units* or *fundamental units* or *standard units*.

The three physical quantities which have been used for long as fundamental quantities for the sake of choosing basic or fundamental units are those of *length*, *mass* and *time*. The basic units of length, mass and time are *metre*, *kilogram* and *second* respectively. Units for most of the other physical quantities for example, area, volume, density, pressure, etc., have been derived from these S.I. Units.

4.5 Multiples and Submultiples of Standard Units.

In every day life we come across distances which are much longer than a

metre and also distances which are much smaller than a metre *i.e.*, long distances and small distances. Thus, for example, the distance between Delhi and Agra is 1,92,000 metres. To express this distance as 192,000 metres is a little inconvenient. Indeed, this distance can be expressed as 192,000 metres = $192 \times 1,000 \text{ m}$ where m stands for metre. Now, if we can define 1,000 metres as another unit a kilometre (km), then the distance between Delhi and Agra could be expressed as 192 km . A kilometre is, therefore, a unit derived from the metre and is equal to 1000 m . Similarly, to express a small distance such as the diameter of a wire which is 0.0005 of a metre, one could say that this distance, 0.0005 of a metre is $\frac{0.5 \times \text{metre}}{1000}$. We define metre/1000 as a millimetre. Thus millimetre (mm) is another derived unit and is 1 metre/1000.

Thus in the S.I. System of Units in which a metre is taken as a Unit of length, the metre is divided into centimetres (cm) and millimetres (mm) and small distances are measured in these units :

$$1 \text{ decimetre (dm)} = 1/10 \text{ metre} \\ = 0.1 \text{ metre}$$

$$1 \text{ centimetre (cm)} = 1/100 \text{ metre} \\ = 0.01 \text{ metre}$$

$$1 \text{ millimetre (mm)} = 1/1000 \text{ metre} \\ = 0.001 \text{ metre} \\ = 1/10 \text{ centimetre} \\ = 0.1 \text{ cm}$$

There are units 10, 100 and 1,000 times the metre. Long distances are measured in these units.

$$1 \text{ decametre (dam)} = 10 \text{ metres}$$

$$1 \text{ hectometre (hm)} = 10 \text{ decametres} \\ = 100 \text{ metres}$$

$$1 \text{ kilometre (km)} = 10 \text{ hectometres} \\ = 100 \text{ decametres} \\ = 1,000 \text{ metres}$$

Just as we have multiples and sub-multiples of the basic unit of length *i.e.*, metre, similarly we have the multiples and submultiples of the basic units of mass and time. They are given as follows :

Mass

$$1,000 \text{ milligrams (mg)} = 1 \text{ gram (g)} \\ 1,000 \text{ (g)} = 1 \text{ kilogram (kg)} \\ 100 \text{ (kg)} = 1 \text{ quintal} \\ 10 \text{ quintals} = 1 \text{ metric ton.}$$

Time

$$60 \text{ seconds (s)} = 1 \text{ minute (min)} \\ 60 \text{ min} = 1 \text{ hour (h)} \\ 24 \text{ h} = 1 \text{ day} \\ 365 \text{ days} = 1 \text{ year} \\ 10 \text{ years} = 1 \text{ decade} \\ 10 \text{ decades} = 1 \text{ century}$$

4.6 Measurement of Length (Measurement in one dimension only)

Linear measurements (*i.e.*, measurements in one dimension only) are measurements of length. The length of a straight line can be measured with a ruler. A ruler is a straight piece of material which has a scale of units marked on it (Fig. 4.4).

Various types of measuring devices such as a ruler, measuring tapes (Fig. 4.5)

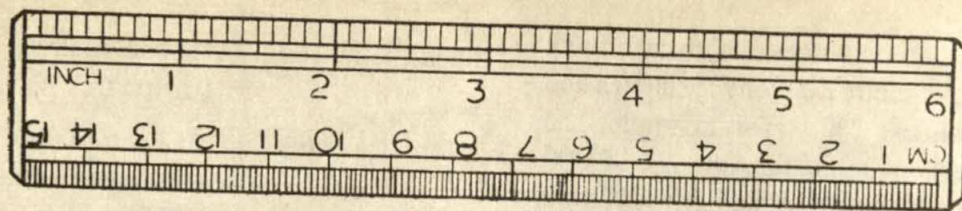


Fig. 4.4 A ruler

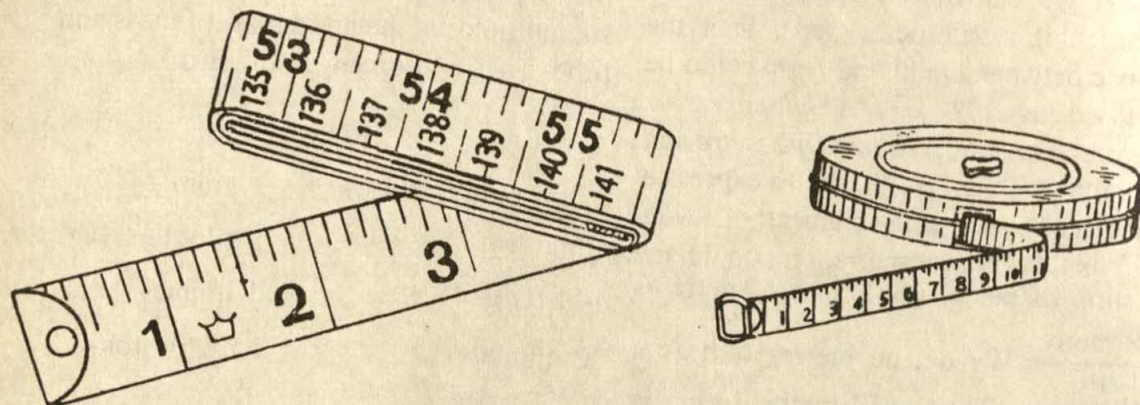


Fig. 4.5(a) Tailor's tape (b) Surveyor's tape

are used by different people for different purposes to measure length. While measuring the length of an object we must choose a proper measuring device. The choice of the device generally depends upon the object to be measured. For example, for measuring small lengths we should choose measuring instruments marked in centimetre. If we are to measure the girth of a tree or a pillar, we have to use a measuring tape because it can be bent. What does a tailor use to measure the chest of a person ?

Proper Use of Instrument

Certain precautions are to be taken while using devices for measuring length.

If these precautions are not taken, our measurements may be wrong. The precautions are as follows :

(i) Keep the scale *parallel* to the length of the object close to it (Fig.4.6), otherwise you would measure more than the actual length.

(ii) If the zero mark of the scale is damaged or the end of the scale may be broken, start measuring from *some full marks* say 1 *cm* (Fig. 4.7) of the scale. Then we must subtract the reading of this full mark from the reading at the other end. For example, in (Fig.4.7) the reading at one end is 1.0 *cm* and at the other end it is 7.3 *cm*. Therefore the length of the object is $7.3 - 1.0 = 6.3$ *cm* and not 7.3 *cm*.

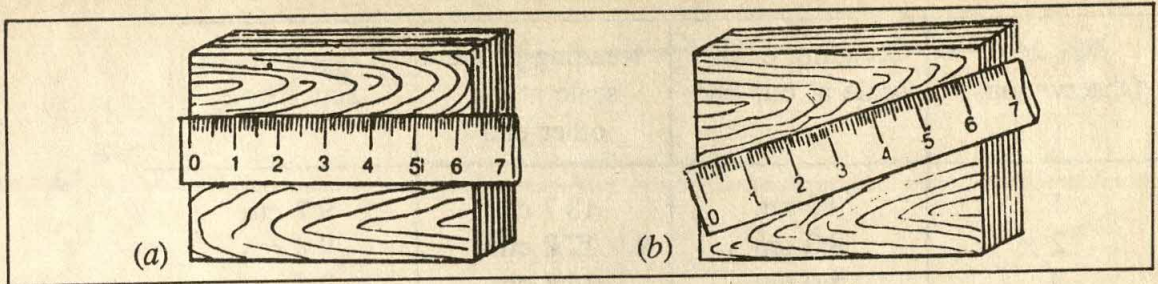


Fig. 4.6(a). Correct placement of scale
(b). Incorrect placement of scale

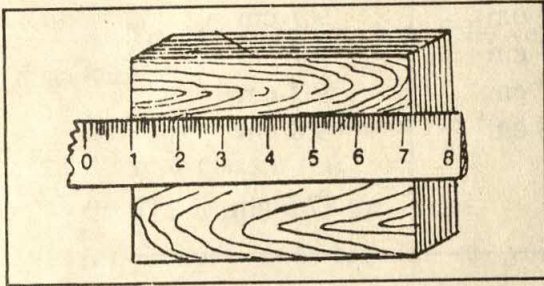


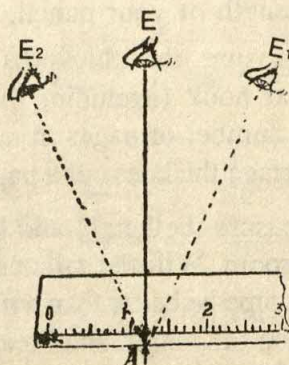
Fig. 4.7

(iii) Read the position of a point say A with the metre scale from three different positions of the eye (Fig. 4.8). Are the three observations same? Obviously not. There is an error called *error due to parallax* because of incorrect position of the eye while taking the reading. This error can be avoided by keeping the eye *vertically above the point* under observation or by keeping the metre-scale perpendicular so that the markings coincide with the point. Note in (Fig. 4.8i) that from position E the reading

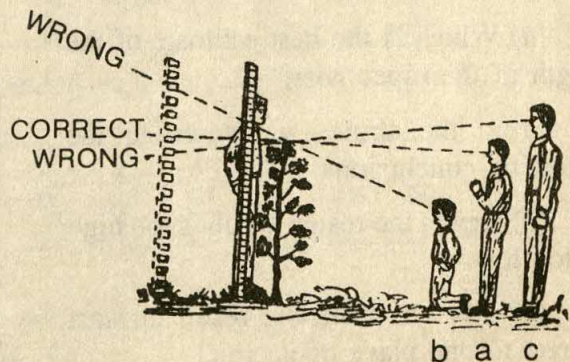
is 1.2 cm. From positions E_1 and E_2 , the readings are 1.3 cm and 1.1 cm respectively. The readings from E_1 and E_2 are not correct.

(iv) If the other end of a line lies somewhere between two mm marks, do not guess to estimate a fraction. Count it as 1 mm if it is more than or equal to $\frac{1}{2}$ mm; and neglect the same if it is less than $\frac{1}{2}$ mm.

In practice, scientists usually take more than one reading when they measure because of the possibility of errors in the measurement. All these readings may or may not give the same value. Where different measurements give slightly different values, we take the average of all the values. For example, in an experiment to measure the length of a rupee note using a metre scale, following readings were obtained :



(i)



(ii)

Fig. 4.8 Error due to Parallax

No. of Observations	Reading of the scale at one end	Reading of the scale at the other end	Length of the rupee note
1	9.0 cm	18.7 cm	9.7 cm
2	8.0 cm	17.8 cm	9.8 cm
3	5.0 cm	14.8 cm	9.8 cm
4	3.0 cm	12.7 cm	9.7 cm
5	6.0 cm	15.6 cm	9.6 cm
6	7.0 cm	16.7 cm	9.7 cm
7	8.0 cm	17.7 cm	9.7 cm
8	9.0 cm	18.7 cm	9.7 cm
9	5.0 cm	14.8 cm	9.8 cm
			87.5 cm

$$\text{Average} = \frac{87.5}{9} \text{ cm}$$

$$= 9.72 \text{ cm}$$

Study these results and answer the following questions :

(a) Which of these results would you reject ? Why ?

(b) Which of these results do you think have been stated too accurately ?

(c) Which of these results have not been given with sufficient accuracy ?

(d) Which is the best estimate of the length of the rupee note ?

From the above, we come to the following conclusions :

(1) Reject the result which is too high or too low.

(2) Always write the result at least correct to one place of decimal.

(3) Whenever there are more readings

find the average value of these readings which will be the best estimate.

Activity

1. Measure carefully the following distances five times and determine the average in each case :

(a) Length, breadth and height of a rectangular block of wood.

(b) Length and breadth of your physics text book.

(c) Length and breadth of an eraser.

(d) Length of your pencil.

2. Measure the thickness of your physics text book (excluding the cover). Count the number of pages in it. Can you get the average thickness of a page ?

3. Measure the length and breadth of your classroom. Will the tailor's tape and Surveyor's tape be better than a metre scale in measuring the length and breadth of the class room ?

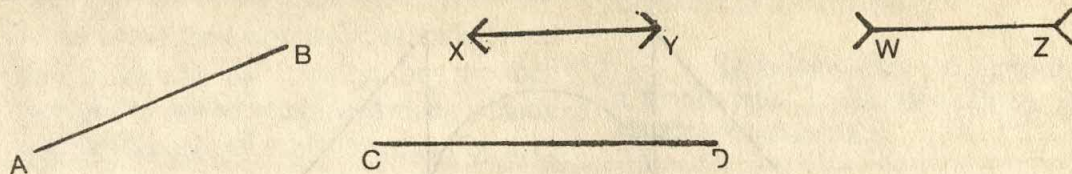


Fig. 4.9

4. Measure the length and breadth of a *duree* on which you sleep.

5. Try to estimate the following distances :

- Length and breadth of the door of your class room.
- The height of your friend.
- Length and breadth of your geometry box.

Check your estimates by actual measurement.

6. Estimate the distance between Kohima and Mokokchung and check your estimate with the help of an atlas.

7. Look at the two lines AB and CD (Fig. 4.9)

Are these two straight lines equal in

length or one is larger than the other ? Use the scale to measure the lengths of lines AB and CD.

What do you find ?

Look at the two lines XY, WZ. Which of them is longer ? Estimate and check your answer by actual measurements.

Beware before you buy

There are many things such as cloth, pipe, laces etc., which are sold by the length. When you go to buy them, you must ensure that the metre-scale used is correct. A correct metre-scale (Fig. 4.10a) has arrow signs $\longleftrightarrow$ on both ends in addition to the stamp of the Weights and Measures Department. An incorrect metre-scale (Fig. 4.10 b) may not have arrow sign on one or both sides.

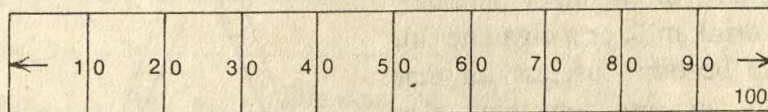


Fig. 4.10 (a) Correct cloth merchant's metre scale

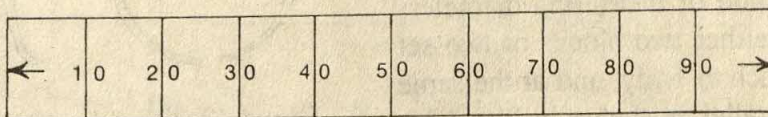


Fig. 4.10 (b) Incorrect cloth merchant's metre scale

Fig. 4.10.

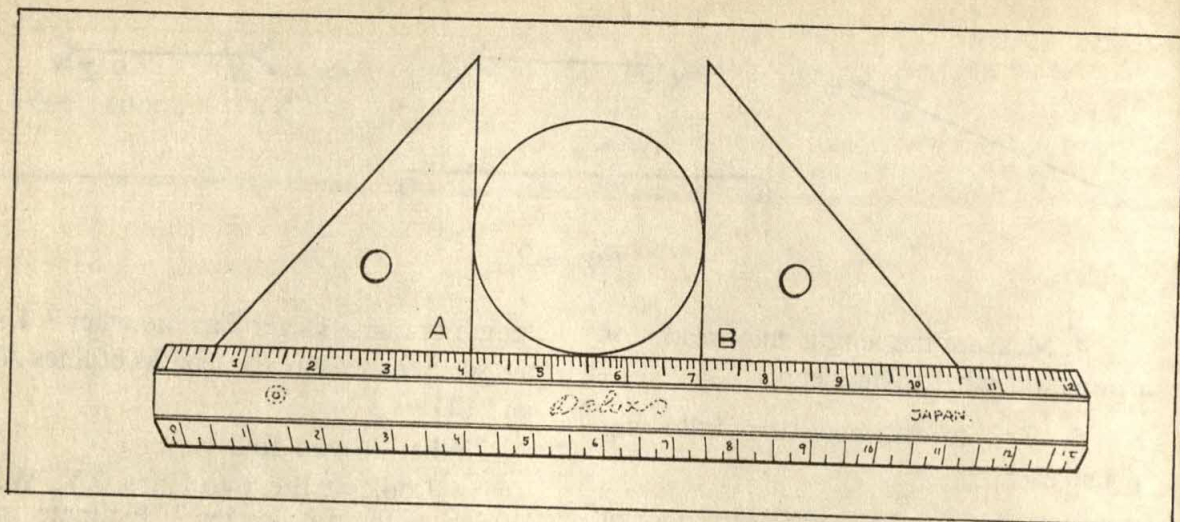


Fig. 4.11 Measuring the diameter of a round object

It may be that the metre has been cut off. This results in short measurement. You must insist on correct measures. You must also ensure that the metre scale has a stamp of the Weights and Measures Department.

Measuring Diameter of Spherical Surfaces

You may sometimes have an occasion to measure the diameter (inside and outside) of a hollow cylinder such as your tea cup or the circumference of the rim of a tumbler in which you drink milk or a cigarette tin. A metre scale becomes useless for that purpose unless you use something else along with it.

One method of measuring diameters is to arrange either two blocks or two set squares to touch to body, and at the same time to be parallel as shown in Fig. 4.11. Then measure the distance between the two parallel blocks or set-squares. In Fig. 4.11 length AB gives the diameter of the sphere.

A more accurate method of measuring diameters of round objects is to use a pair of 'inside' or 'outside' calipers, depending on whether you are measuring the internal or external diameter. Fig. 4.12 (a) and (b) shows what the calipers look like. The two kinds are usually combined, and one can be changed into the other by turning it completely round.

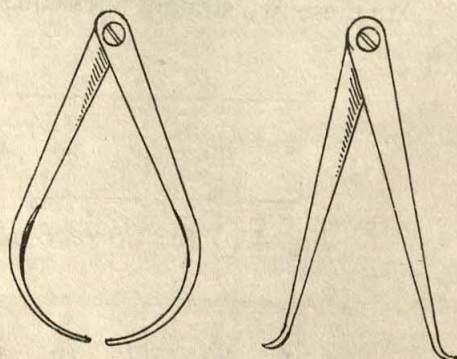


Fig. 4.12. Outside and inside calipers

Fig. 4.13 (a) and (b) shows how the pairs of calipers are used to measure

external and internal diameters respectively. In each case the calipers are extended until they fit the cylinder exactly; they are then carefully removed and placed along a metre rule for measurement as shown in Fig. 4.13 (c).

To give you a bit of practice in the use of set squares try this experiment :

Activity

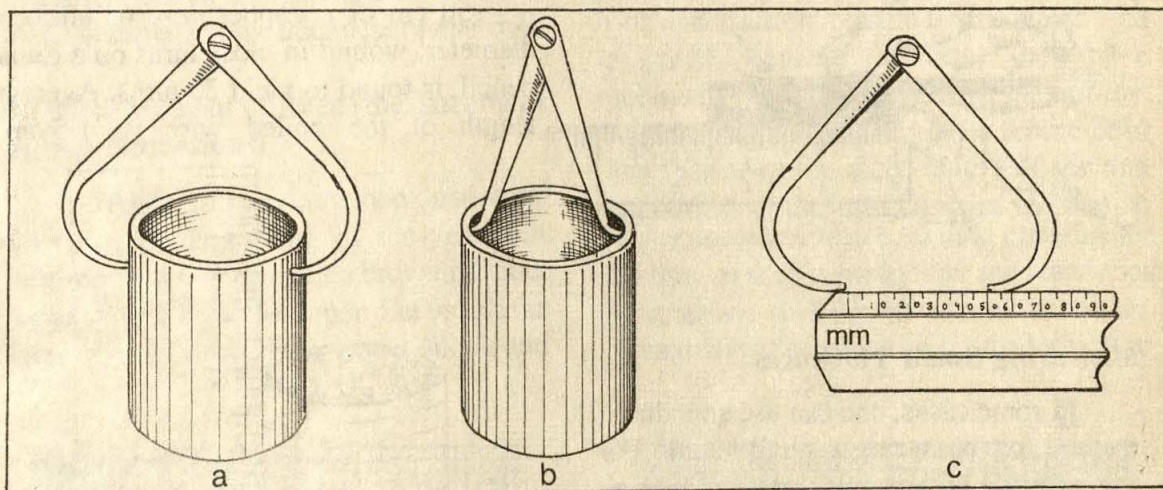
To measure the internal and external diameters of a cylindrical tin and the

diameter of a tennis ball.

Requirements : A cylindrical tin, a tennis ball, a pair of calipers, two set squares, a metre rule.

Procedure : Take the measurements by the method described above, taking care that in the first method the set squares are strictly parallel, and in the second method the calipers fit in exactly.

Record your readings in the following manner :



(a) External diameter (b) Internal diameter (c) Measuring along a metre rule

Fig. 4.13. (Measuring the diameters of a tin using calipers.)

	Trials	Diameter of ball (cm)	External diameter of tin (cm)	Internal diameter of tin (cm)
1st Method using Set- squares	1st			
	2nd			

	3rd
	Average
2nd Method using Calipers	1st
	2nd
	3rd
	Average

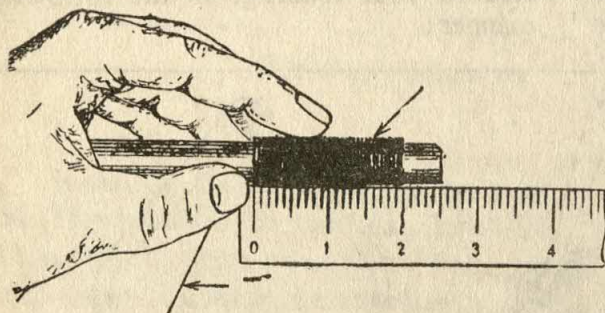


Fig. 4.14

Measuring Small Thickness

In some cases, one can use an indirect method for measuring a small length. For example, it is certainly not possible to measure the diameter of a thin copper wire by direct measurement using a scale. Why? But we can determine the diameter of a thin copper wire by indirect measurement as follows :

Wind a piece of given thin wire say thirty times round a pencil so that there are no spaces between the turns. Measure the average length of the coil thus formed with the help of the metre-scale (Fig. 4.14) and calculate the diameter of the wire by dividing the length of the coil by the number of turns. Care must be taken that the wire is of uniform diameter.

Example

50 cm of a copper wire of uniform diameter, wound in close turns on a round pencil, is found to yield 20 turns. Average length of the coiled wire is 1.5 cm.

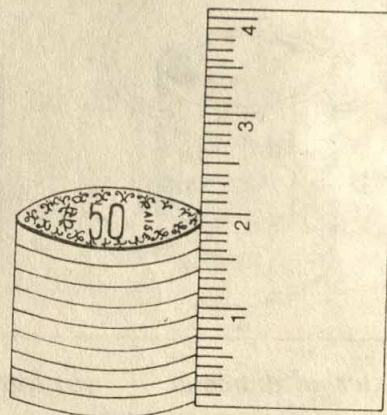


Fig. 4.15

Calculate the diameter of the wire.

Average length of the coiled wire
(l) = 1.5 cm

Number of turns (n) = 20

Diameter of the wire = $l/n = 1.5/20$

= 0.075 cm = 0.75 mm

= 7.5×10^{-2} cm

= 7.5×10^{-4} m

We can measure the thickness of a sheet of paper out of a thick bundle or the diameter of an office pin by such an indirect method of measurement using a metre-scale. (One can use a suitable adhesive or plasticine etc., to hold temporarily the pins in position).

You can determine the thickness of a 50 paise coin as shown in Fig. 4.15. First prepare a stack of 10 fifty paise coins. Measure the thickness of this stack by using metre scale as shown in Fig. 4.15. Divide this thickness by 10 (the number of coins in the stack) to get the thickness of one coin.

4.7 Measurement of Area (measurement in two dimensions)

When you buy new book and note-books at the beginning of the year, you probably cover them with a brown paper or some other decorative paper. Let us take an atlas, a note-book and a pocket-book and

put covers on them. You can perhaps answer the following question. Will the paper required to cover the atlas be more than that required to cover the note-book? If the answer is yes, think for yourself as to why you require more paper to cover the atlas than that required to cover the note-book which, in turn, is more than that required to cover a pocket-book although the pocket-book is thicker than the note-book and the atlas.

Take a sheet of white paper and place it on the table. Place on the paper a match box and mark its outline on the paper with a pencil. Replace the match box by a geometry box and again mark the outline. Repeat the process, first with a note-book and then with the atlas. You will see that the outline of the atlas contains the outline of the notebook which, in turn, contains the outlines of the geometry box and match box. This means that the portion of the paper occupied by the match box is the least. The

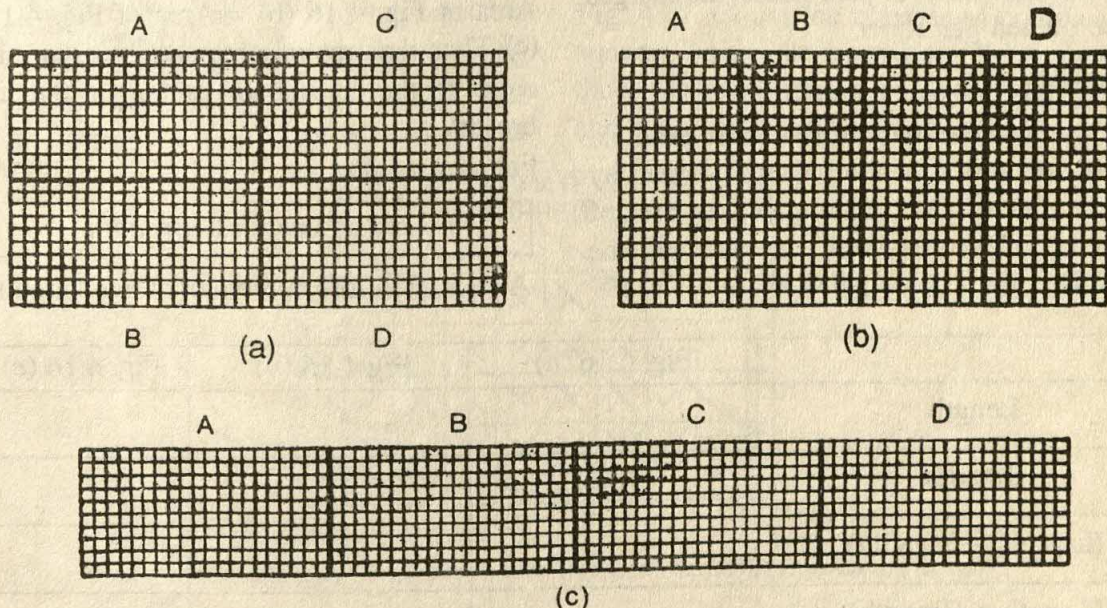


Fig. 4.16

portion of the paper contained by the outlines of each of these bodies is the area of those faces of these bodies which were in contact with the paper. You see thus that the area of the face of a match box is less than the area of the face of a geometry box etc. The area thus denotes the size of a surface or it is the measure of surface of an object.

So far we have merely compared areas. We shall now see how they can be measured. The need to measure area is felt in every day life. If a farmer buys a field, he says, "I want 5 hectares of land." If you want to build a house, you may need a plot of land measuring 1,000 m². These terms — 5 hectares, 1,000 m² etc. — are the area of the land. If you want to buy a piece of plywood or a sheet of glass, the price of the materials required is quoted in terms of a square metre which is one of the units of area. Similarly if you want to tile the floor or paint the walls of your house, the charges are quoted per sq.m.

Activity

You have seen in the earlier example that the portion of the paper contained by an outline of a notebook gives the area of the face of the note-book in contact with the paper. Take a graph paper and place a note-

book on the graph paper and mark its outline. Cut the graph paper along outline. The area of the graph paper is the area of the face of the notebook. Measure the length and breadth of the graph paper and enter the readings in the following table. Cut the graph paper into four equal parts along the thick lines as shown in Fig. 4.16(a) Arrange four pieces in the shapes shown in Fig. 4.16(b) and Fig. 4.16(c).

Since the same paper is arranged in these patterns, the area of Fig. 4.16(b) is equal to the area of Fig. 4.16(c) which is equal to the area of the face of the notebook. Measure the length and breadth of the Fig. 4.16(b) and Fig. 4.16(c). Tabulate the readings.

From these observations you will see that although the length and breadth change as you go from Fig. 4.16(a) to 4.16 (b) and to 4.16 (c), the product of length and breadth remains the same. We have also seen that the area of Fig. 4.16 (a) = Area of Fig. 4.16 (b) = Area of Fig. 4.16 (c). Thus the area of a rectangular figure is equal to the product of its length and its breadth.

For a rectangle,

$$\text{Area} = \text{Length} \times \text{Breadth}$$

Area is, therefore, a product of two lengths.

	Fig. 4.16 (a)	Fig 4.16 (b)	Fig. 4.16 (c)
Length			
Breadth			
(Length + Breadth)			
(Length x Breadth)			

Just as we measure length by comparing the unknown length with some known length, we measure area by comparing the unknown area with a known area. Since the area of a rectangle is defined as the product of its length and its breadth, the unit of area could be defined in terms of the unit of length and the unit of breadth. Thus a convenient and accepted unit of area is the area of a square whose length is 1 m and breadth 1 m. This area is $1 \text{ m} \times 1 \text{ m}$ and is expressed as 1 sq m or 1 m^2 . It is the standard unit of area.

As in the case of length, to express bigger and smaller areas, multiples and sub-multiples of this unit are used. These are

$$1 \text{ are} = 100 \text{ m}^2$$

$$1 \text{ hectare} = 100 \text{ are} = 10000 \text{ m}^2$$

$$1 \text{ sq km} = 1 \text{ km} \times 1 \text{ km} = 1 \text{ km}^2$$

$$1 \text{ sq cm} = 1 \text{ cm} \times 1 \text{ cm} = 1 \text{ cm}^2$$

$$1 \text{ sq mm} = 1 \text{ mm} \times 1 \text{ mm} = 1 \text{ mm}^2$$

The area of a country or that of a field is expressed in the convenient units 'are' and 'hectare'. The area of a small object

such as a towel book etc., is expressed in cm^2 and the area of still smaller objects is expressed in mm^2 .

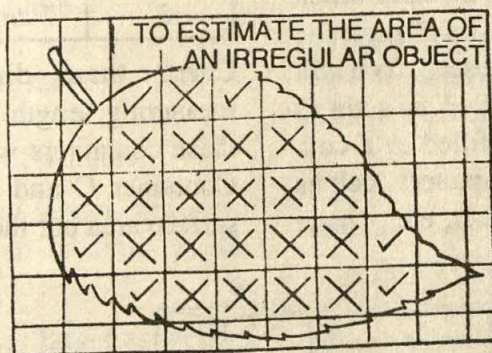
Activity

(i) Take a graph paper. Cut out a square of side 1 cm from the graph paper. This, as you will see, is one of the big squares on the graph paper. Each small division on the graph is 1 mm. Count the number of small squares in the bigger square. What is the area of one small square? How many small squares make up a big square? Is $1 \text{ cm}^2 = 100 \text{ mm}^2$?

(ii) Draw a square with the side equal to the length of your pencil and measure its area by measuring its length and breadth.

How can the area of shapes other than squares and rectangles be found?

Take a squared cm paper. Draw the boundary of the given irregular figure (say that of a leaf) on the paper as shown in the Fig. 4.17. Count the number of complete squares inside the boundary. Next count those squares which are inside the boundary and which are cut in such a way that more



Put a $\times$ in the complete squares

Put a $\checkmark$ in the squares which are more than half covered by a leaf

No. of $\times$ =

No. of $\checkmark$ =

Area of leaf = cm^2 .

Fig. 4.17 To estimate the area of an irregular object

than half the square is inside the boundary. Consider them as full squares. Neglect the squares which are of area less than $1/2 \text{ cm}^2$. By adding the number of more than half the square to the number of complete squares we get the total area of the irregular figure in cm^2 .

Activity

- Find the area of a 10 paise coin by using the *mm* graph paper.
- Using tracing paper, draw an outline map of India from your school atlas on the graph paper. Find the area enclosed by your outline in square centimetres. From the scale of the map estimate the actual area of India in km^2 .

4.8 Measurement of Volume (Measurement in three dimensions)

In everyday life we come across expression such as “a cup of milk,” “a tin of kerosene,” “a bucket of water,” “a bottle of ink,” etc. What do we understand by these expressions? You will, perhaps, say that a cup of milk means the milk which fills a given cup. Similarly a tin of kerosene would mean a tin full of kerosene. You will agree that the kerosene filled in a tin is much more than the milk filled in a cup. Thus each of the above containers such as a cup, a bottle, a tin, a bucket, etc., have

different capacities for holding liquids. The capacity of a container is called its *internal volume* or simply the *volume*. Thus the volume of kerosene oil contained in a tin is many times more than the volume of milk contained in a cup. Thus we can say that the volume of a container is the amount of space it occupies.

Again a book occupies more space than a match box. Also a basketball occupies more space than a hockey ball. The space occupied by an object is called its volume.

On what factors does volume depend? To answer this question let us perform the following activity:

Activity

Take three different containers say A, B, C as shown in Fig. 4.18. The length, breadth and height of these containers are shown below:

Container	Length	Breadth	Height
A	6 cm	5 cm	6 cm
B	5 cm	3 cm	6 cm
C	5 cm	3 cm	5 cm

Check these dimensions by actually measuring length, breadth and height of these containers with the help of a scale. Container C and B have bases of same surface area but their heights are different.

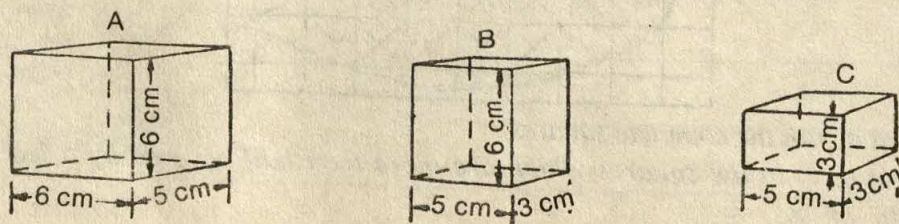


Fig. 4.18

On the other hand, containers B and A have the same height but have bases of different surface area. Find out which container has the largest volume and which container has the smallest volume by filling the container A with water and then pour this water into containers B and C. Can you find out the relation between the volumes of these containers? Is there any relation between the volumes of these containers and the *areas* (i.e., lengths $\times$ breadths) of their bases and heights?

You will find that to measure the volume of a container, we have to measure three lengths : two lengths (i.e., length and breadth) for the area of one face and the third for the height of the object. *Volume is thus the product of three lengths.*

Volume of a body of rectangular shape = Length $\times$ Breadth $\times$ Height

Like measurement of length and area, we measure volume in terms of a unit which is generally acceptable as a standard. A unit of volume is defined as the volume of a cube which has an edge of 1 metre length.

Therefore unit Volume

$$= 1 \text{ m} \times 1 \text{ m} \times 1 \text{ m}$$

$$= 1 \text{ cu m (cubic metre)}$$

$$= 1 \text{ m}^3 \text{ (cubic metre)}$$

It is the standard unit of volume.

The volume of any vessel or a solid body will then be given in terms of the volume of this cube.

To express volumes larger as well as smaller than a m^3 , it is desirable and convenient to use multiples or submultiples of the metre-cube (m^3). These derived units are :

$$1 \text{ cu km} = 1 \text{ km} \times 1 \text{ km} \times 1 \text{ km} \\ = 1 \text{ km}^3$$

$$1 \text{ cu cm} = 1 \text{ cm} \times 1 \text{ cm} \times 1 \text{ cm} \\ = 1 \text{ cm}^3$$

$$1 \text{ cu mm} = 1 \text{ mm} \times 1 \text{ mm} \times 1 \text{ mm} \\ = 1 \text{ mm}^3$$

Volume of Liquids

To measure the internal volume of vessels or the volumes of liquids and gases a unit called litre (l) is used. A cubical box with inside dimensions of 10 cm on each side has a volume of $1,000 \text{ cm}^3$. *This volume is called a litre.* A thousandth part of a litre is called a millilitre (ml). One millilitre is equal to 1 cm^3 .

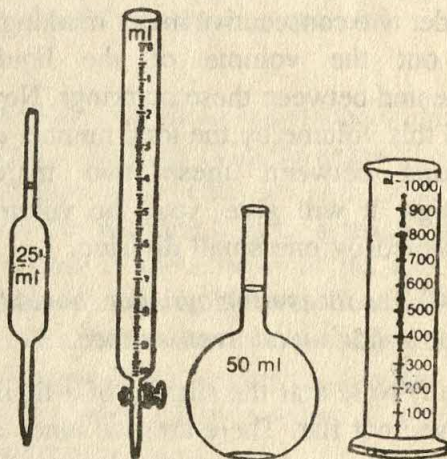


Fig. 4.19 Pipette, Burette; Measuring flask and Graduated cylinder respectively

$$1,000 \text{ ml} = 1 \text{ l} \\ 1 \text{ ml} = 1 \text{ cm}^3$$

Fig. 4.19 shows graduated vessels used in the laboratory. The measuring cylinder is used for measuring or pouring out desired volumes of liquid. The measuring flask and pipette are used for obtaining fixed volumes. The burette delivers any required

volume upto its total capacity and is made long and narrow. There is a stopcock at its lower end to adjust the flow of liquid. The liquid is poured from the top and its level is noted. It is taken out from the bottom by opening the stopcock. The level of liquid in the burette falls and is noted again. The difference in the levels of the liquid gives the volume of the liquid taken out.

The measuring cylinder has to be used carefully. The following steps should be taken while using the measuring cylinder :

(i) Find the volume of a liquid which is represented by one small division.

For that observe the scale carefully. Consider two consecutive major markings. Find out the volume of the liquid represented between these markings. Now divide this volume by the total number of divisions between these two major markings. It will give you the volume represented by one small division.

(ii) The measuring cylinder should be kept on a horizontal even surface.

(iii) Note that the surface of a liquid is curved not flat. There are two kinds of curved surfaces: *Concave meniscus* (Fig.

4.20 a) and *Convex meniscus* (Fig. 4.20 b). Most liquids such as water, kerosene and alcohol have concave surfaces while some, such as mercury and molten wax, have convex surfaces.

The eye should be in level with the lower most point of the concave meniscus and with the upper most point of the convex meniscus. Fig. 4.20 (a) and (b) shows the correct position of the eye in reading the scale.

The Volume of Solids having Irregular Shapes

An object can be *regular* in shape (i.e., it has a regular volume), or *irregular* in shape (i.e., it has an irregular volume). Cylinders and spheres are examples of objects with regular volumes while stones and fruits are examples of objects with irregular volumes. Volumes of regular bodies such as sphere, cylinder or cube can be obtained by direct measurement and substitution in well-known formulae. By when the body has an irregular shape like the piece of a stone, it is not all that easy. However, if you remember that no two things can occupy the same space at the

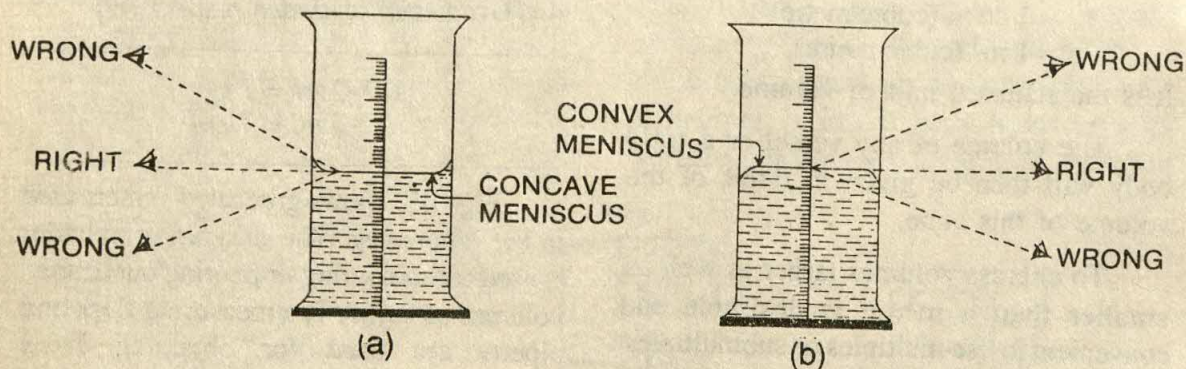


Fig. 4.20 Reading the level of a liquid

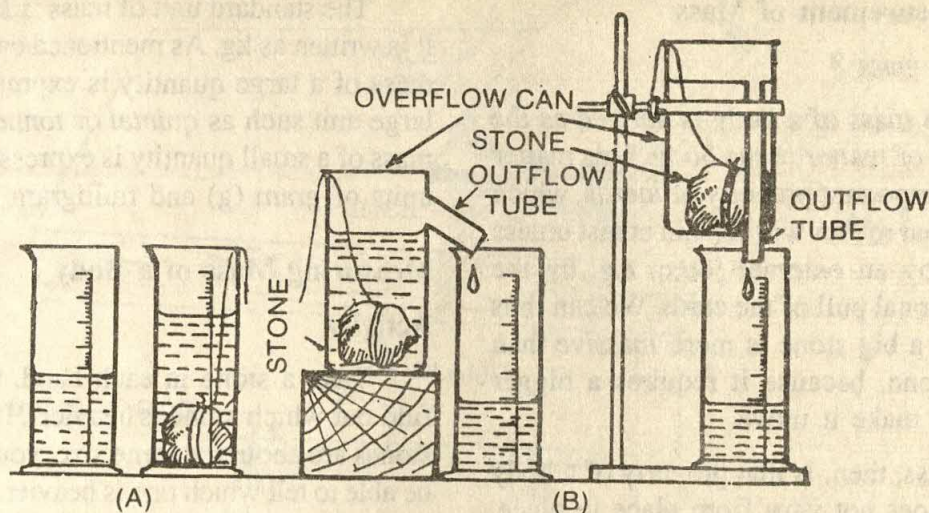


Fig. 4.21 (a) Using a Measuring Cylinder.

(b) Using an overflow can and a measuring cylinder.

same time, you can then measure the volume of the body by finding what volume of liquid it displaces i.e., by the method of displacement.

Pour some water into the graduated cylinder (you should have enough water to cover the stone when it is later immersed). Read the meniscus and record your reading. Holding the string carefully let the stone into the water and gently lower it to the bottom of the cylinder Fig. 4.21 (a). When the water is steady, read the meniscus again and record your reading. Do this three times, and from your readings, note the change in water level and the volume of the stone will be known to you. In fact the difference in the two levels gives the volume of the piece of stone.

If the body is a little bigger, an overflow can is used Fig. 4.21(b). Fill the overflow can with water, until the over-flow starts to flow out of the over-flow tube.

When the over-flow has stopped, place an empty measuring cylinder below the over-flow tube. Now gently lower the stone into the water with the help of a string until it is resting at the bottom of the can. The displaced water will over-flow into the cylinder. When the flow has stopped, read the volume of the water in the cylinder. This reading gives you the volume of the stone directly.

The method of displacement can be used for solids such as sugar which will dissolve in water. You only need to use a liquid in which they will not dissolve i.e., kerosene for sugar.

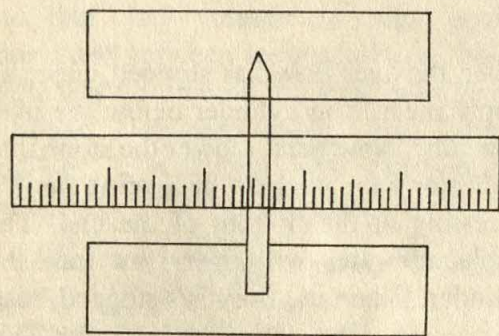
The method can also be used for solids such as cork and rubber which will float in water. You use either a liquid in which they will sink or a *sinker* i.e., a heavy object tied to the cork which will make it sink and whose volume you will have to find separately.

4.9 Measurement of Mass

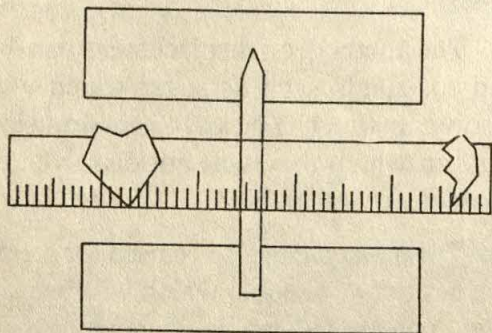
What is mass ?

The *mass of a body is defined as the quantity of matter in the body*. This matter has the important property of *inertia*, which means that matter will remain at rest unless moved by an external force, *e.g.*, by the gravitational pull of the earth. We can thus say that a big stone is more *massive* than a little one, because it requires a bigger force to make it move.

Mass, then, is that property of a body which does not vary from place to place. Wherever the stone is, it has the same mass, the same quantity of matter in it.



(a)



(b)

Fig. 4.22 (a) A balanced ruler
(b) Stone balanced on a ruler

The standard unit of mass is *kilogram*. It is written as kg. As mentioned earlier, the mass of a large quantity is expressed in a large unit such as *quintal* or *tonne* and the mass of a small quantity is expressed in the units of *gram* (g) and *milligram* (mg).

Measuring Mass of a Body :

Activity

Take a stone in each hand. Can you find out which stone is heavier ? If the two stones are about the same size, you will not be able to tell which one is heavier. But you can use a see-saw to find out which one is heavier.

Place a pencil on two piles of books and balance a ruler on it Fig. 4.20 (a). Now place one stone on each side of the ruler and move them until the ruler is balanced Fig. 4.20 (b). Find out how far each stone is from the pencil. The stone nearer to the pencil is the heavier one or more massive. Now you know how a simple weighing machine works. We have found a method of measuring the mass of a substance. We have simply to compare it with the known mass of another body. To do this we can use a *clamp balance* or a *beam balance*. Let us make a simple clamp balance. For your clamp balance, you will need a clamp, a bamboo rod about 1 metre long, a round pencil, two similar tin lids each with three small holes and a piece of thin string.

First of all, put the pencil under some heavy books so that it juts out over the edge of a desk (Fig. 4.23). Next, put the two wire holes of the clamp on to the pencil so that the clamp swings freely. By opening and shutting the clamp, place the bamboo rod

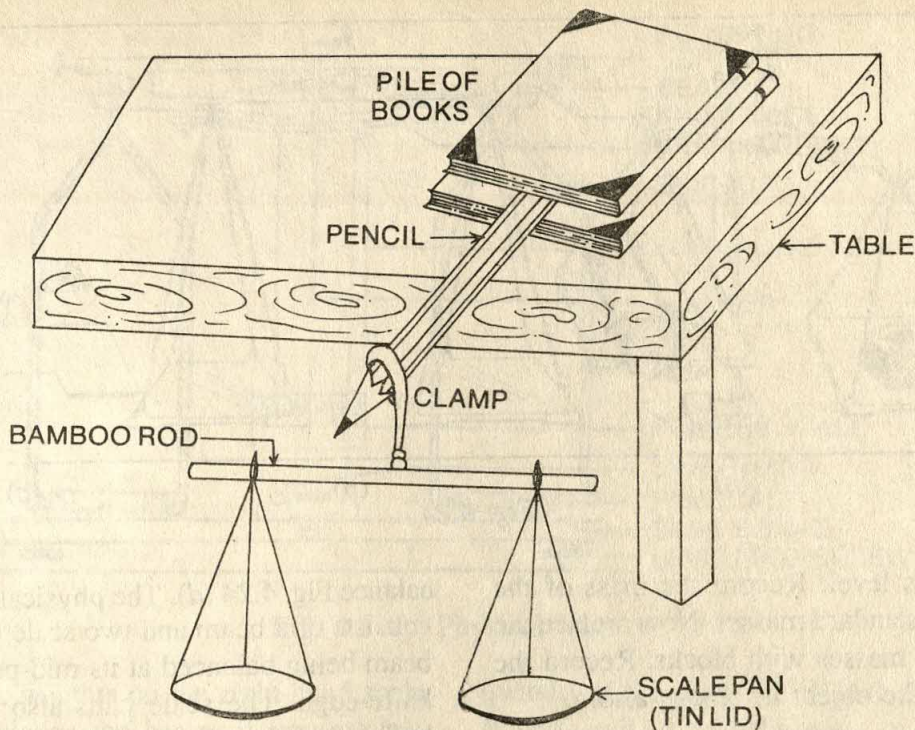


Fig. 4.23 A clamp balance

in a position where it balances. Make pencil marks at each end of the rod at equal distances from the clamp. Using a razor, blade, make a little groove at each pencil mark. The grooves are for keeping the strings in place.

Now, to make the scale pans, tie the thin string to the three holes in the tin lids. Next, hang the scale pans from the grooves, first making sure that the rod is levelled. The pans must be placed at equal distances from the clamp. Do the pans balance? If they do not, stick some plasticine on the lighter pan. Now your clamp balance is ready for use.

Use your clamp balance to compare the masses of some objects such as peanuts, rubber, chalk and small stones. Place these objects on the scale pans and balance them

with other objects. Find out which objects are heavier and which are lighter.

To compare the masses of different objects properly, we must have standard masses. We can make our own standard masses by filling bottle-tops with plasticine. Now balance these bottle-tops against one another. Make sure they all have the same mass by taking away or adding plasticine to them.

Place a standard mass on one scale pan and some threading blocks on the other. Find out how many threading blocks are balanced by one standard mass.

You can use your clamp balance to find the mass of a stone, a pan, a small ruler and so on. Place the object in one scale pan and standard masses in the other until the

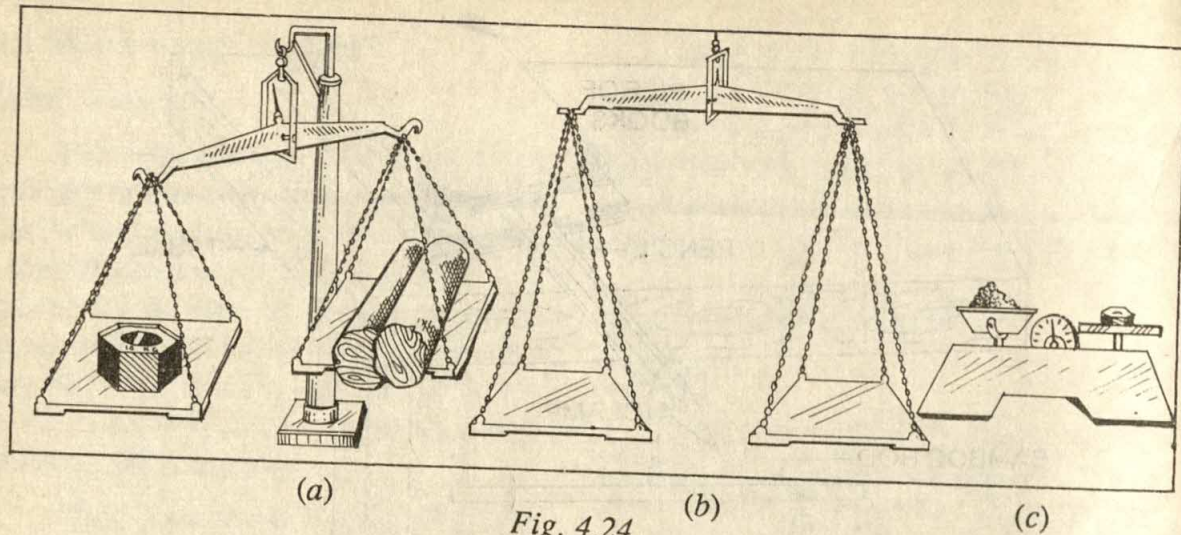


Fig. 4.24

balance is level. Record the mass of the object in standard masses. Now replace the standard masses with blocks. Record the mass of the object in blocks also.

Figure 4.24 (a), (b), (c), (d) shows a variety of beam balances which are used for measuring mass.

The balance shown in Fig. 4.24(a) or (b) or (c) is an ordinary grocer's balance. The two pans may be arranged on either side of the beam which has got to be balanced about a point either by suspension or better above the sharp edge of a prism. It hardly matters much if the grocer's balance actually measures 1000.5 g or 999 g of sugar with a 1 kg mass. But it will matter several rupees if a goldsmith's balance weighs a difference of 1 g or 0.5 g and a druggist's balanced weighs a difference while preparing a medicine where even a small grain of excess might risk the patient's life. Hence we need a very accurate and sensitive balance which could indicate the difference in mass, upto a very small fraction of a gram. In Science we use such a balance known as the physical

balance Fig. 4.24 (d). The physical balance consists of a beam and two scale pans, the beam being balanced at its mid-point on a knife-edge. The scale pans also hang on knife-edges by means of *stirrups* and rest on the *baseboard*. When the balance is not in use the beam rests on the beam support. The balance is kept closed inside a glass case (not shown). This saves it from the dust and air draughts of the room.

How to Use the Balance

(i) Use the levelling screws attached beneath the baseboard to make sure that the beam is perfectly horizontal. It will be when the *plumb-line* is pointing exactly above the small pointer.

(ii) Use the handle to raise the beam and the *adjusting screw* at the two ends of the beam, to bring the pointer to the middle or zero mark on the scale.

(iii) Lower the beam, using the handle again.

(iv) Place the body to be weighed on the left-hand scale pan, and put standard

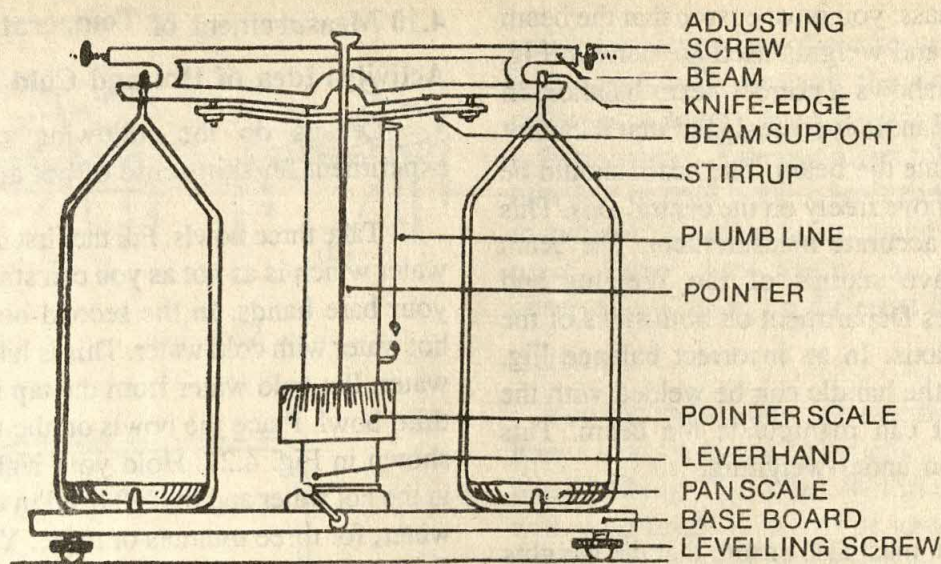


Fig. 4.24 (d) Physical balance

masses or weights on the right-hand scale pan to balance the beam. If you are left-handed, you will have to place the body on the right-hand scale pan. Continue to adjust the weights until the beam is balanced, *i.e.*, when the pointer is at zero.

Note that in order to weigh a certain fixed mass of a substance, you fix the weights (standard masses) and vary the

quantity of the substance till both are equal. If you want to find the mass of a given substance, you vary the weights till both are equal.

Beware Before You Buy

There are many things in the market which are sold by the mass. When you go to the market to buy things which are sold

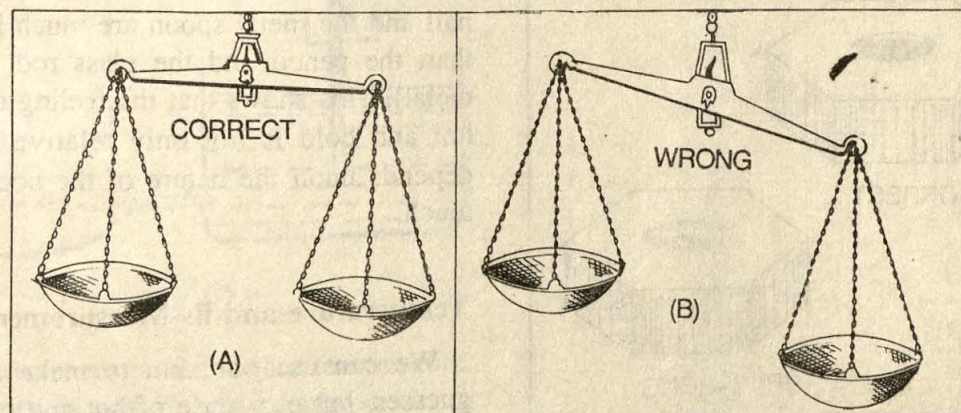


Fig. 4-25

by the mass, you must ensure that the beam balance and weights used are correct. Fig. 4.25 (A) shows a correct beam balance. In this, the handle is so designed that it cannot manipulate the beam. The beam should be able to move freely on the central axis. This ensures accurate measurement. The beam must have stamps of the Weights and Measures Department on both sides of the central axis. In an incorrect balance Fig. 4.25(B) the handle can be welded with the beam. It can manipulate the beam. This results in under-weighing.

You must also ensure that the weights used are correct. The amount of weight is written on the upper side of the weight. The weight is made of metal. It has a hole at the bottom in which some lead is filled Fig. 4.26(A). There is a stamp of Weights and Measures Department in the centre of the lead. An incorrect weight may not be of metal. Some metal weights may not have lead filling and they may not have the stamp of the Weights and Measures Department Fig. 4.26 (B). This also results in under-weighing.

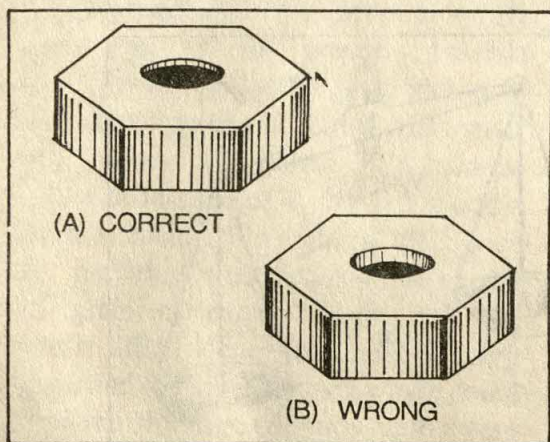


Fig. 4.26

4.10 Measurement of Temperature

Activity : Idea of Hot and Cold Bodies

Let us do the following personal experiment on skin sense of hot and cold.

Take three bowls. Fill the first one with water which is as hot as you can stand with your bare hands. In the second bowl mix hot water with cold water. This is lukewarm water. Put cold water from the tap into the third bowl. Place the bowls on the table as shown in Fig. 4.27. Hold your right-hand in the hot water and the left-hand in the cold water, for three minutes or more. You will find that your right-hand feels hot and your left-hand feels cold. After three minutes move both your hands into the lukewarm water. What do you feel ? Your left-hand feels warm and your right-hand feels cold. But both hands are in the same bowl of water! You cannot really tell if a thing is hot or cold by feeling it. This shows that the feeling of the hot and cold is relative.

Fill a can with hot water. Put into it a pencil, a nail, a glass rod and a metal spoon. Feel the tops of these articles after two or three minutes. You will feel that the nail and the metal spoon are much hotter than the pencil and the glass rod (non-metal). This shows that the feeling of the hot and cold is not only relative but it depends upon the nature of the body we touch.

Temperature and its Measurement

We can use our skin to make *rough* guesses, but our sense of hot and cold is limited and unreliable. Our sense of touch can be used only to determine which of the

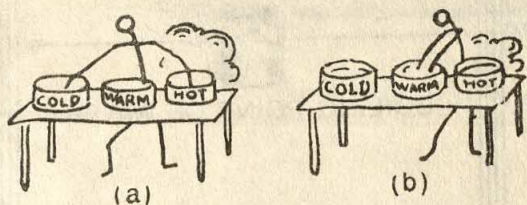


Fig. 4.27

which is independent of our sense of touch and which will measure the hotness or coldness of a body. Such a device is called a *thermometer*. A thermometer tells us just how hot or cold a thing is; it can be used to compare different objects; and it can be used again and again, to link up observations made on different days.

Activity

You can make your own thermometer at home using a bottle, plasticine, and thin plastic tubing (Fig. 4.28). Warm the bottle with your hands to drive out some air and get the water level at a suitable height.

Note how the level of the water varies as the temperature is varied. If you cool the

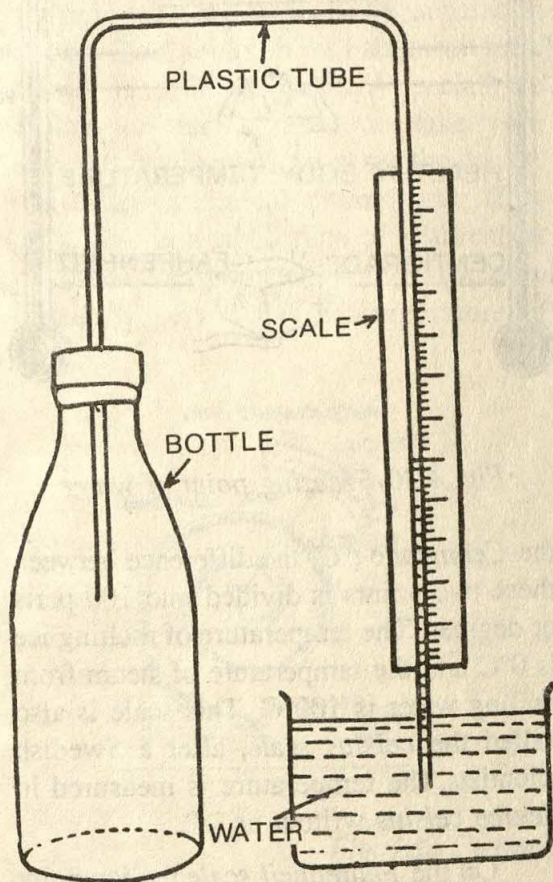


Fig 4.28

two substances is at a higher temperature. It cannot be used if the two substances are almost at the same temperature, nor can it be used for very high and very low temperatures. We, therefore, need a device

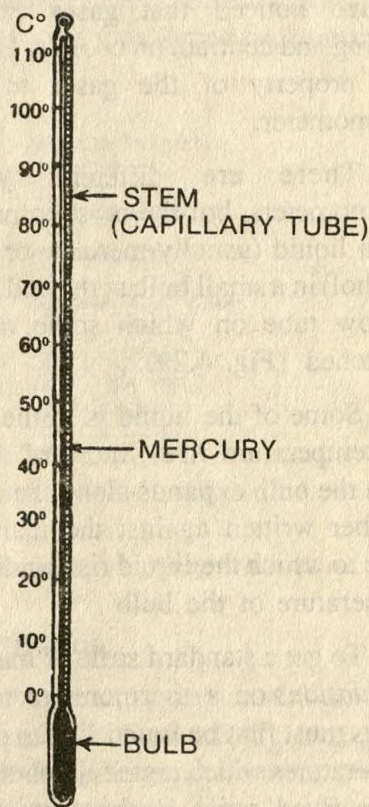


Fig. 4.29

bottle by pouring cold water over it, the water level in the tube will rise further. If you heat the bottle by bringing a candle flame near it, the water level in the tube will fall. The change in the level of water in the tube thus indicates the change in temperature. In this particular experiment, fall in the level of water in the tube indicates rise in temperature and the rise in the water level in the tube indicates fall in the temperature.

The temperature of a thing is a measure of its degree of hotness or coldness.

The above model of an air thermometer is similar to the one devised by Galileo in the sixteenth century. In fact he developed the first thermometer. Galileo noticed that gases expand on heating and contract on cooling. He utilised this property of the gases to build a thermometer.

There are different types of thermometers, but the most common type has a liquid (usually mercury or coloured alcohol) in a small bulb at the end of a long, narrow tube on which some marks are scratched (Fig. 4.29).

Some of the liquid is in the tube. As the temperature rises, more of the liquid from the bulb expands along the tube. The number written against the mark on the scale to which the liquid rises indicates the temperature of the bulb.

To get a standard scale of *markings or graduations* on a thermometer two *fixed points* must first be found. These points are temperatures which are easily obtained. The upper fixed point is the temperature of steam from boiling water. The lower fixed point is the temperature of melting ice. In

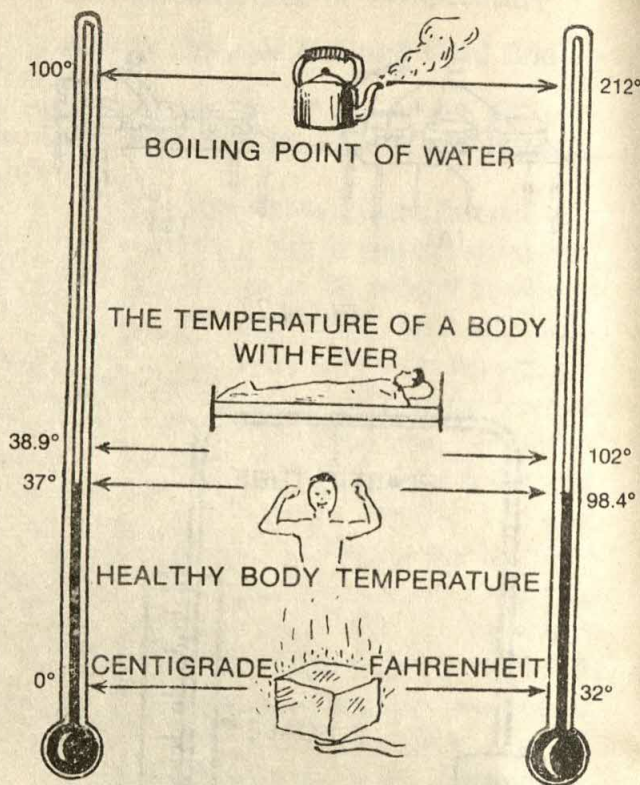


Fig. 4.30 Freezing point of water

the *Centigrade* ($^{\circ}\text{C}$) the difference between these two points is divided into 100 parts or degrees. The temperature of melting ice is 0°C and the temperature of steam from boiling water is 100°C . This scale is also called the *celsius scale*, after a Swedish scientist. The temperature is measured in *degree celsius* written as $^{\circ}\text{C}$

On the *Fahrenheit* scale the ice point is 32°F (degree Fahrenheit) and the upper fixed point is 212°F (Fig. 4.30). This scale came about because the two fixed points that the inventor, Fahrenheit, used were the temperature of the body, which he then thought was 96°F and the temperature of a mixture of ice and salt which was 0°F .



Fig. 4.31 A clinical thermometer

It has since been found that the temperature of a normal human body is 98.4°F . Today, most people, including scientists, use the Centigrade scale. The Fahrenheit scale is much less important. The separation between fixed points on the Fahrenheit scale is divided into 180 divisions. A special type of thermometer is used to take your temperature when you go to see the doctor. It is called a clinical thermometer (Fig. 4.31). This is a small type of (Fahrenheit or Celcius) thermometer about 10 cm long. A healthy person has a temperature of

thin capillary tube with a narrow portion (or constriction) at A (Fig. 4.28). In expanding the mercury flows out of the bulb past the narrow portion, but when the thermometer is taken out of the patient's mouth or armpit the mercury does not flow back past the constriction.

Thus the temperature can easily be recorded and read.

To bring the mercury back into the bulb, the thermometer is shaken vigorously and the mercury is thus forced back through

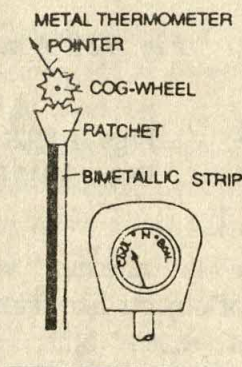
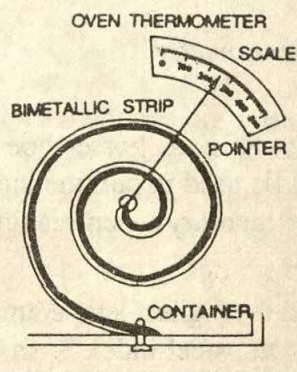


Fig. 4.32 Thermometers for measuring high temperatures

98°F (or 37°C). Any great deviation indicates illness. 105°F is regarded as very dangerous. To obtain the temperature of a patient the nurse usually places the thermometer under the tongue or in the armpit. This thermometer has a short, very

the constriction.

The instrument is graduated from 95° to 110°F (or 35°C to 42°C), it is also used by veterinary surgeons to measure the temperature of animals. Here is a list of a few body temperatures of healthy animals.

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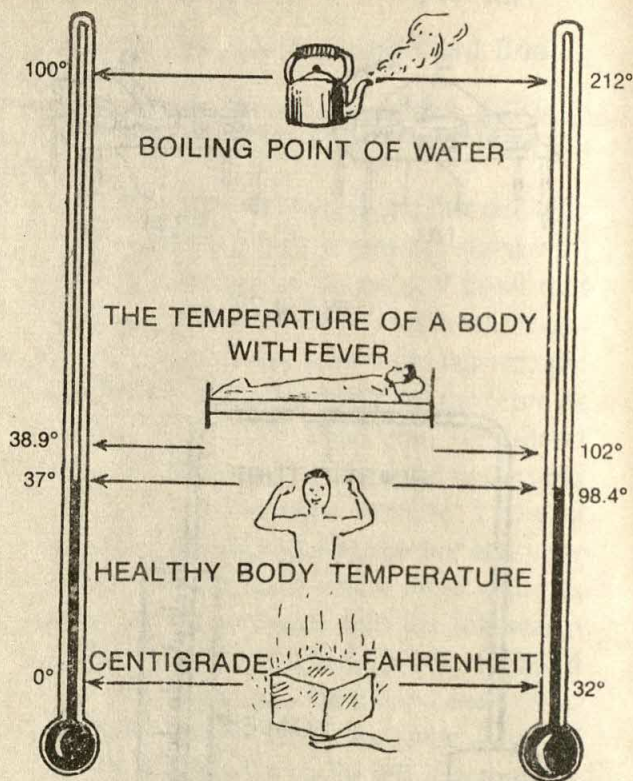


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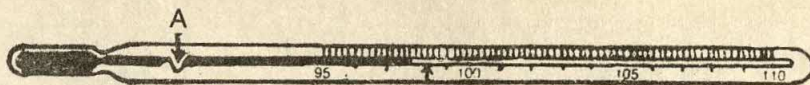


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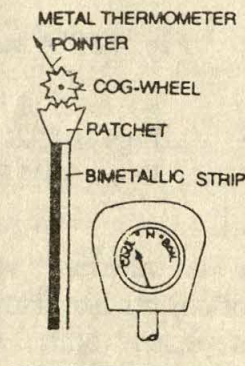
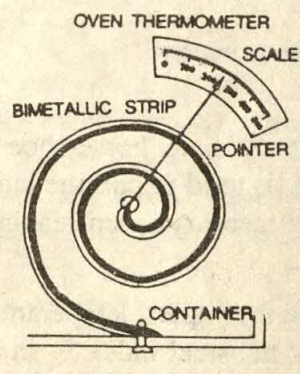


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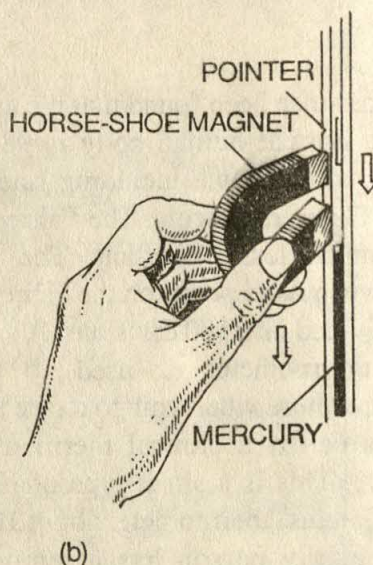
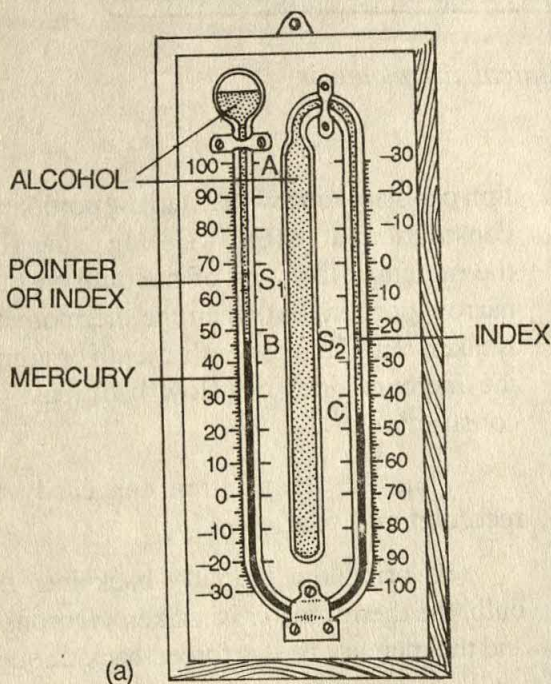


Fig. 4.33 A maximum and minimum thermometer

Horses 100° F	Pigs 102.2° F
Sheep 104° F	Dogs 101° F
Fowls 107.6° F	

In order to measure very high temperatures of objects like flames, ovens and furnaces many other types of thermometers have been designed (Fig. 4.32).

The *Six's maximum and minimum thermometer* is used to register the highest and the lowest temperatures for the day. As the mercury in the thermometer [Fig. 4.33 (a)] rises or falls it pushes up one of the small steel pointers or indices (plural of index) S_1 and S_2 . A small spring is attached to each index to prevent it being pulled down when

the mercury falls. A horse-shoe magnet [Fig. 4.33 (b)] is used to pull the index back to touch the mercury when readings have been taken.

To read the highest temperature of the day, look at the steel index S_1 in the tube AB and read the temperature indicated by the *bottom end* of the index. This gives the highest temperature for the day. You can then use the magnet to pull down the index to touch the mercury at B.

To read the lowest temperature of the day, read the temperature indicated by the *bottom end* of the index S_2 in the tube CD. Use the magnet again to pull down the index to touch the mercury at C.

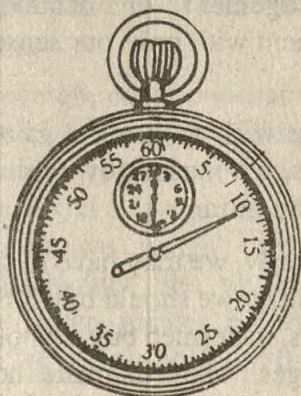
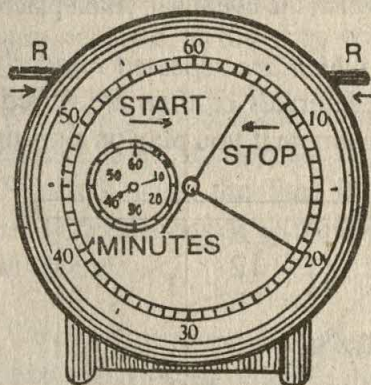


Fig. 4.34 (a) Stop watch



(b) Stop clock

Note that the tube AB is graduated from the bottom upwards and the tube CD from the top downwards.

4.11 Measurement of Time

Knowledge of time is very important in everyday life. Whenever you want to travel by public transport or the train or Air India, you have to know the time when the bus or the train or the jet aeroplane leaves. If you do not reach the bus stand or the railway station or the airport on time, you may miss your bus or the train or aeroplane. In order to watch Ramayana on T.V., you have to know the time when to switch on T.V. in order to watch this favourite serial. If your school starts at 8.00 A.M. you have to reach school on time, otherwise you will be marked absent.

Time can be measured only by means of something that happens *regularly*. Our day and night are caused by the regular rotation of the earth on its axis. This regular occurrence gives us the day. Now the day has been sub-divided into hours, minutes

and seconds by means of something swinging to and fro (that is, *oscillating*) about a mean position and known as the *pendulum*. The credit of this discovery goes to an Italian Scientist, Galileo Galilei.

The Standard Unit of time all over the world is *second* (s). A watch measures time. In scientific work and in athletics it often becomes necessary to measure accurately the time during which an event takes place e.g. the time it takes a hot body to cool from 90° C to 40° C or the time it takes an athlete to run 100 m. In such cases the *stop watch* [Fig. 4.34 (a)] or *stop-clock* [Fig. 4.34 (b)] is required. You can measure time accurately upto half a second with a stop-clock and upto 1/10 or 1/100 of a second with a stop watch.

When the event begins the watch is pressed or the lever RR of the stop clock is pushed and thus started. As soon as the event is over, the watch is pressed again or the lever of the stop-clock is pushed again and thus made to stop. The time now shown by the stop-watch or stop-clock is the exact

time during which the event has taken place.

Events which are repeated regularly and at equal intervals of time are called *period*. For example if you play on a swing

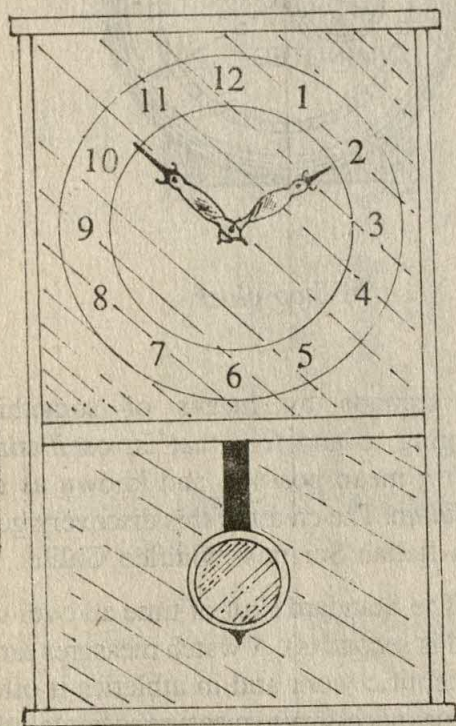


Fig 4.35

the time it takes to swing from one side to another is always constant whether you play on it in the morning or evening in winter or in summer. The motion of the swing is called *periodic motion*. This principle of periodic motion is used in making watches (Fig. 4.34) and wallclocks (Fig. 4.35). The pendulum is made to work a chain of the wheels which move the hands of the clock. In watches and small clocks the balance wheel does the same thing as the pendulum does in wall clocks.

4.12 Estimation and Measurements

In our daily life, we often have to make a

quick judgement or decision about measurement with only our senses to help us.

If we wish to bring 3 kilograms of vegetables, we must know which sack to carry to the bazar.

Similarly, we may have to guess how much fertilizer we should buy for our field. Sometimes, tradesmen buy a whole crop of, say, oranges. They estimate how many oranges they would get from the crop and then bid the price. If they guess wrongly they would lose money. Both the buyer and the seller need the skill of estimation.

You want to reach school in time. Your school is, say, 1 kilometre away from your house. You can walk to the school in 20 minutes or you can take a bus. What will you do? Walk or wait for the bus? To decide, you will estimate time.

It is, therefore, useful to be able to estimate correctly. What do we do when estimate? When we make estimate we use only our senses. We recall from memory similar experiences in the past. We make a comparison and then arrive at a decision. *Estimation is a comparison just as measurement is.* Is estimation as reliable as measurement? Obviously not. Looking at a heap of onions, you can estimate whether they will weigh 20 kg or 30 kg but can you tell whether they will weigh 21 kg or 22 kg? Probably not.

Estimation is a skill. You can improve your skill by practice.

Accuracy in Measurement

The accuracy in measurement depends upon the need and the value of the material.

The following examples will make the point very clear to you:

(i) When we weigh, coal or wheat we do not need very high accuracy. Neither you nor the shopkeeper is likely to be worried if you have received a few grams more or less. But when we weigh cardamom (*ilaichi*) or cashewnuts, etc., we try to be very accurate. Even greater accuracy is needed when we weigh gold or silver.

(ii) Mustard oil or kerosene is measured

rather quickly and roughly but when you measure perfume, every drop counts !

(iii) When we go to see someone, we need to be punctual to the minute but in Olympic and National races, the time is recorded accurately in fractions of a second to decide the winner etc.

We can have more examples from our daily experience. Can you give three more examples ?

SUMMARY

1. Our senses cannot make correct measurement.
2. Measurement of a physical quantity is a process of comparing it with a standard unit.
3. Standard units of measurements are necessary for the purpose of uniformity.
4. Standard units of length, mass and time are metre, kilogram and second respectively.
5. For measuring of certain length, we must choose our scale according to (i) the length we have to measure, and (ii) the accuracy with which it has to be measured.
6. Measurement of width, height and depth involves the process of measuring length.
7. The main sources of error in measuring length are :-
 - (i) error in placing the scale,
 - (ii) incorrect position of the eye while taking the reading, certain precautions have to be taken while using a metre-scale.
8. Special techniques are used to measure small thickness.
9. Estimation of measurement is an important and useful skill.
10. Area is derived from two lengths. The area of a rectangular object is found by multiplying its length and breadth.
11. The standard unit of area is m^2 . Smaller areas are expressed in cm^2 and mm^2 whereas larger areas are expressed in 'are' and 'hectare'.
12. The area of irregular objects can be found with the help of a graph paper.
13. *Volume* of an object is the space occupied by it. The capacity of a container is the space available in it.
14. Volume is the product of three lengths. The volume of a rectangular solid is found by multiplying its length, breadth and height.
15. Volume is expressed in the units of m^3 , cm^3 or mm^3 .

16. Volume of liquids and gases is expressed in the units of *litre* or *millilitre*.
17. When the body has an irregular shape like a piece of stone, a key etc., we used method of displacement to measure the volume of such a body. The volume of the body is equal to the volume of the liquid displaced.
18. Mass of an object is the quantity of matter present in it.
19. Mass of an object is expressed in the units of kg, g or mg.
20. Mass is measured by using a *beam balance* and a set of known weights i.e., it is measured by comparing the given mass with an equal amount of known mass from a set of standard masses.
21. Measurements have to be made accurately.
22. Temperature is the degree of hotness of an object.
23. The unit of temperature is $^{\circ}\text{C}$.
24. Temperature is measured by using a thermometer.
25. The thermometer used for measuring human body temperature is called *clinical* thermometer. It can measure only a short range of temperatures from about 35°C to 42°C . The temperature of a normal human body is 37°C .
26. Events which repeat regularly and at equal intervals of time are called periodic.
27. Periodic events are used for measuring time interval.
28. The Standard Unit of time is *second* (s).
29. For accurate measurements of time (upto $1/10$ th of a second), a *stop-watch* is used.

QUESTIONS

1. Which are the measures and the units in the following :

(i) 5 arm-lengths	(ii) 10 palmlength
(iii) 2 kilometres	(iv) 10 centimetres
2. Can palm-length, arm-length or a foot-length be used as a standard unit of measurement ? If not, why ?
3. The height of the Qutab Minar is 72 m. What will be its height in km and mm. Which is the most convenient unit to express the height ?
4. The diameter of a human hair is 0.005 mm. Express this in cm.
5. If you want to paint your room in such a way that the roof is painted cream yellow and the walls light green, will you require the same amount of yellow and green paint ?
6. Is the area of the face of an atlas greater than the area of the face of a note-book ?
7. The area of a table is 840 times the area of a match box surface; 70 times the area of a geometry box surface; 80 times the area of a postcard; 2016 times the area of

a stamp; 100 times that of a square card-board sheet of length 10 cm.

In these expressions, which are the measures and which are the units?

8. Express (a) 1 m^2 in term of cm^2 ; mm^2 ; dm^2
(b) km^2 in terms of m^2 ; cm^2 .
9. Will the measurement of area by a graph paper be more accurate than the measurement of area by measuring length and breadth?
10. How could you find out the thickness of one page of this book ?
11. Using the mm graph paper find the area of (i) 5 paise coin (ii) 50 paise coin.
12. A glass block measures $10 \text{ cm} \times 2 \text{ cm} \times 2 \text{ cm}$. What is its volume? How many cubical blocks, each $2 \text{ cm} \times 2 \text{ cm} \times 2 \text{ cm}$ are there in it?
13. A glass box has a 6 cm^2 base and contains water to a height of 7 cm.
 - (i) What is the volume of the water?
 - (ii) A stone is lowered into the water so that it is completely under water and the water rises to a height of 9 cm. What is the volume of the stone?
14. How will you find the volume of :
 - (i) a small lump of sugar ?
 - (ii) a small cork ?
15.
 - (a) What do we mean by a standard unit ?
 - (b) Is estimation as reliable as measurement ? Give examples.
 - (c) From where can we obtain correct standard measures ?
16. Read the following sentences and write *True* for the correct ones and *False* for the wrong ones :
 - (i) Liquids like water, milk and medicines are measured by volume. (True/ False)
 - (ii) A shopkeeper is not obliged to keep proper standards and to get them checked regularly. (True/False)
 - (iii) A tailor makes measurements very accurately. (True/False)
 - (iv) Estimation is not a skill. (True/False)
 - (v) There are no submultiple units of the basic unit of time. (True/False)
 - (vi) A common scale always produces confusion. (True/False)
 - (vii) Observation is an important part for making measurements. (True/False)
 - (viii) Our country has adopted a system of measurement which is the Metric System of Measurement (Metre, Kilogram and Second) (True/False)
 - (ix) There are units bigger or smaller than the standard units of length, mass and time. (True/False)

17. Which of the following is a standard unit of length ?
(i) metre; (ii) millimetre; (iii) decimetre; (iv) centimetre.
18. State the precautions which should be taken while using a metre scale to measure length.
19. What type of scale would you use to measure your chest ?
20. Handspan and Cubit cannot be used as standard units of length, Why ?
21. How many decimetre² are equal to 1 m²?
22. The length of a rectangle field is 60 m and its breadth is 50 m. Calculate its area in *are* and *hectare*.
23. A houseowner wanted 200 tiles of the size 5 cm x 5 cm to cover the floor. When he went to the market, he found that tiles of only 4 cm x 4 cm were available. How many tiles will he have to buy?
24. If the area of a rectangular sheet of a metal is 450 cm² and its length is 30 cm, calculate its breadth.
25. What is meant by the capacity of a container ?
26. Describe the method used to determine the volume of an irregular solid which is heavier than water and insoluble in it.
27. Fill in the blanks :
 - (i) The volume of an object is the occupied by it.
 - (ii) The volume of liquids is expressed in
 - (iii) 1 cm³ is equal to ml.
 - (iv) To read the volume of a liquid in a measuring cylinder, it should be kept on a surface.
 - (v) The lower fixed temperature in celsius thermometer is the melting point of an object.
 - (vi) Temperature is the measure of of an object.
 - (vii) The thermometer used to measure human body temperature is called thermometer.
 - (viii) The normal temperature of human body is °C.
28. What is mass ? What is the standard unit of mass ?
29. How many quintals make one metric ton ?
30. Under what two conditions the mass of an object is to be measured correctly ?
31. How will you ensure that a beam balance is correct ?
32. Calculate the mass of water in a tank of length 80 cm, breadth 60 cm and height 20 cm, if the mass of 1 cm³ of water is 1 g.

33. A small water-tight cubical box has sides 1 cm each. Sixty-four drops of water from a dropper can fill the box completely. What is the volume of one drop of water ?
34. The standard unit of time is
(i) hour (ii) day (iii) second (iv) minute
35. What are periodic events ?
36. What kind of watch is used to measure the time of sports events ?
37. Why is it necessary to have standard units of measurement ?
38. Describe the method of finding the area of an irregular object such as the palm of your hand.
39. State the precautions to be followed while finding out the volume of a liquid using a graduated cylinder.
40. Match the physical quantities given in Column I with their units given in Column II.

Column I

Time
Length
Temperature
Volume
Mass

Column II

metre³
metre²
metre
degree Celsius
second
kilogram

41. Draw a diagram of the laboratory (mercury) thermometer. Mark the lower and upper fixed temperatures on a Celsius Scale.
42. Match the physical quantities in Column I with their meanings in Column II.

Column I

Mass
Area
Volume
Temperature

Column II

Distance between two points
Space occupied
Degree of hotness
Quantity of matter
Measure of the surface of an object.

43. In modern times, time must be measured accurately in fractions of a second. Give some examples where you think such measurements are necessary.
44. What is measurement ? Why is it called a two-step process ?

ACTIVITIES

1. Try to estimate the following lengths and check your estimates by actual measurements. Take each reading three times and find its average.

Object	Estimated Length	Actual Length
(i) Length of your bed-room (ii) Height of your father (iii) Breadth of your cot (iv) Girth of a tree		

2. Try to estimate the areas of the following objects and check your estimates by actual measurements. Take each reading three times and find its average.

Object	Estimated Area (m^2)	Length (m)	Breadth (m)	Actual area = Length $\times$ Breadth (m^2)
(i) Bed room floor (ii) Bed room window (iii) Hindi text book (iv) One page of a newspaper (v) Door				

3. Try to estimate the Volume of the following objects and check your estimates by actual measurements. Take each reading three times and find its average.

Object	Estimated Volume (m^3)	Length (m)	Breadth (m)	Height (m)	Actual Volume = Length $\times$ Breadth $\times$ Height (m^3)
(i) Your science book (ii) Brick (iii) Match box					

- (iv) Your bedroom
 - (v) Your Teacher's demonstration table
-

4. You are given two similar empty shoe polish tin cans (or coconut shells) each with three small holes; a bamboo rod about 50 cm long, a round pencil; a piece of tin string, a clamp, some heavy books and a desk. Make a simple beam balance.
 - (i) Use your beam balance to compare the masses of peanuts, chalk and small stones. Find out which objects are heavier and which are lighter.
 - (ii) Make your own standard masses by filling bottle-tops with plasticine and find the mass of a stone, a pen and a small ruler in terms of your standard masses.
5. Take a laboratory (mercury) thermometer and measure the temperature of (a) fresh water from the tap in a tumbler, (b) some hot milk in a glass, (c) 500 cm³ of palm oil after it is heated for 2 minutes.
6. Take a clinical thermometer and measure the temperature of your friend's body.
7. You are given an empty tin can with its top face cut and having a very small hole with a nail in the centre at the bottom of the can; two bricks; water and a stop-clock. Make a water-clock and use it to find the time-taken by you to count 200.

CHAPTER V

CHANGES AROUND US

In our daily life we observe materials undergoing various changes — when coal burns, it changes into ash and smoke; ice changes to water upon heating, and changes into steam on boiling. Ponds, lakes, rivers etc., dry up during summer.

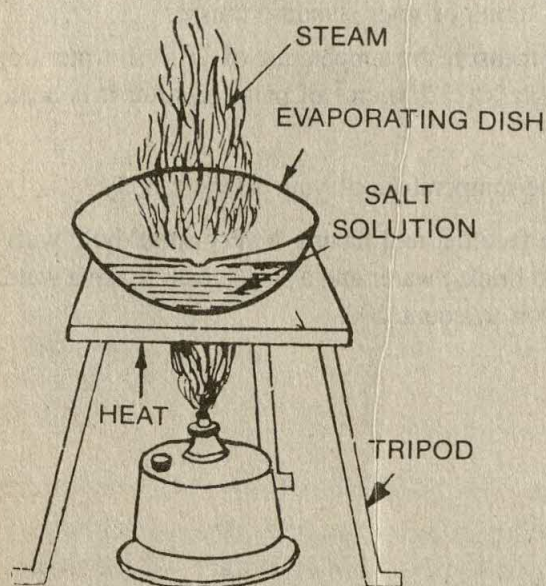


Fig. 5.1 Evaporation of a Salt Solution

Many changes take place when the day ends and the night sets in. During the day time there is lot of light, stars are not visible in the sky, some animals like butterflies, birds are active. Flowers like *Rat-ki-Rani* do not bloom. On the other hand, during the night time there is very little light, stars are visible, birds are not so active.

These and the many other changes which substances undergo can be classified into two types of changes—Physical and Chemical changes.

5.1 Physical Change

(a) The process of making a solution is usually considered to be a physical change because it is easy to reverse by removing to solvent. Add some sugar or salt into water and stir well. Soon sugar disappears forming sugar solution. On evaporating the solution, sugar is left behind.

(b) The passage of an electric current through copper wires or the filament of a lamp produces no new substance and the wire is unchanged, when the current is switched off.

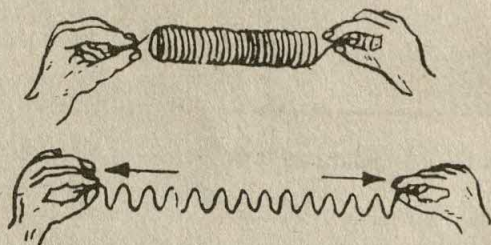


Fig. 5.2 Spring elongates on applying force

(c) Take a spring. Hold it at its two ends. Apply some force horizontally. The spring becomes longer. Now release the spring. It returns to its original shape and length.

In all the above experiments we have seen that no new substances are formed. The substances remain unaltered and the changes could be reversed. Such changes are called *physical changes*.

A physical change is one in which no

new substance is formed, only there may be change in physical properties. Change is temporary and can be reversed. Changes in heat energy usually are small.

5.2 Chemical Change

(a) When magnesium is heated in air, it burns with a brilliant white light leaving a white powder called magnesium oxide.

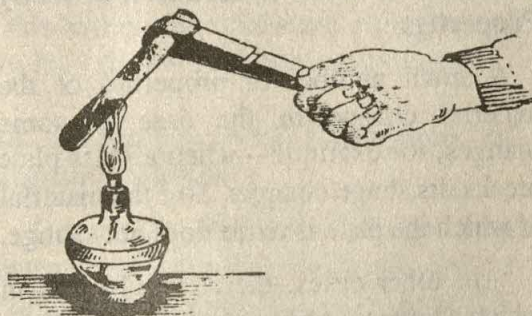


Fig. 5.3 Sugar burning into carbon

(b) Heat some sugar in a test tube. Some sugar turns into a black residue (carbon) giving off steam. These two new substances, carbon and steam do not recombine on cooling to give back sugar.

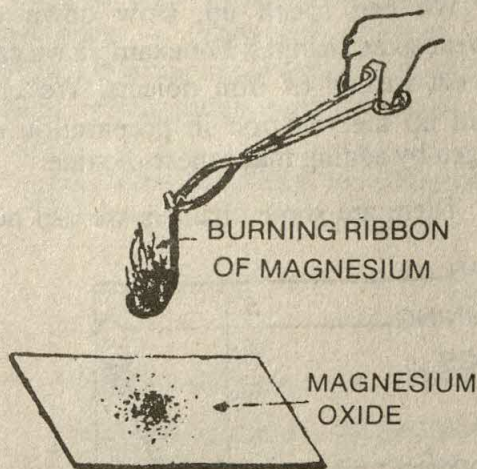


Fig. 5.4 Burning of magnesium

(c) When silver nitrate solution is mixed with sodium chloride solution a white solid is formed which sinks slowly

to the bottom of the test tube.

The solid formed, when two solutions are mixed together, is called a *precipitate* and the reaction is called *precipitation*.

In all the above experiments we have seen that the substances underwent a change in composition and gave rise to new substances. Such changes are called chemical changes and are not easily reversible.

A chemical change is one in which one or more new substances are formed with different properties. Change is permanent and cannot be reversed. Usually it is accompanied by large changes in heat energy.

5.3 Slow and Fast Changes

Some changes are fast *e.g.*, change that occurs in a photographic plate when a photograph is taken or the burning of a match stick. These changes occur in less than a second. Some other changes are slow, for example, the growth of a baby, the change of season. These changes take place over hours, days or months.

5.4 Desirable and Undesirable Changes

Some changes are desirable *e.g.*, changing wheat flour into chappati. Some other changes are not desirable like the changes that occur when food is kept open for a longer time during summer days.

You will realise that some change can be desirable at one time but undesirable at some other time, for example, when milk becomes curd.

5.5 Periodic and Non-Periodic Changes

When a change occurs after a fixed

interval of time that change is periodic. Our heart beat, the phases of the moon etc., are some examples of periodic changes. In the case one can predict when it will occur again.

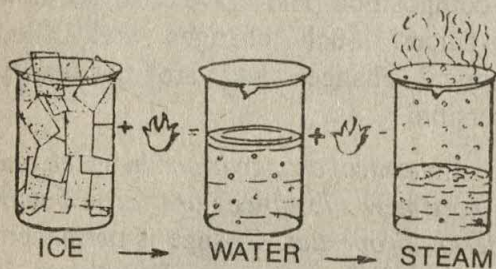


Fig. 5.5. Melting of ice into water

The melting of ice into water, the growth of a plant, the rusting of an iron nail —these changes are not periodic. It cannot be predicted when any one of these changes will occur the next time.

5.6 Reversible and Irreversible

Ice upon heating changes into water and when cooled changes into ice. The leaves of the rain tree fold after sun set and open out again after sun rise. Similarly when you put a weight on a rubber band

it stretches. When you remove the weight, it comes to its original position. These are the few examples of reversible changes. When a piece of paper burns, it changes into smoke and ash. You cannot get back a piece of paper from smoke and ash. It is a kind of chemical change. These are irreversible.

5.7 A change may effect a new or many Properties

A small number of properties of the material change in the case of some changes, for example—when a glass plate breaks, its shape changes. But the material of which the plate is made does not change.

In other cases, there are changes in which a large number of properties change. For example when food is cooked, many properties change. Also, when hydrogen combines with oxygen it forms water.

5.8 Can we control changes ?

We can speed up, slow down or prevent some changes. For example we can prevent rusting of iron objects. We can speed up the reaction in preparation of oxygen by adding manganese dioxide.

There are some changes we can not

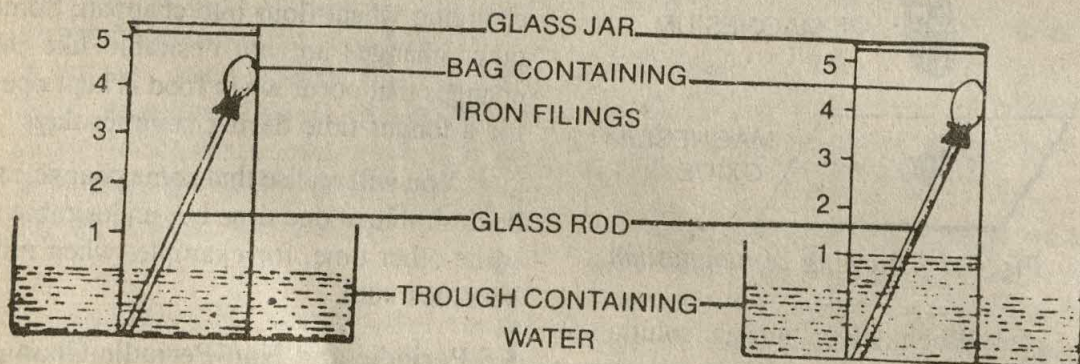


Fig. 5.6 The rusting of an iron nail

control, for example, rotation and revolution of the earth are beyond our control.

5.9 Think before you change something

Before changing we should think carefully. Some changes may seem to be of immediate use but turn out to be harmful later. For example, we cut down trees in the forests for timber or fire-wood. As a result of this action, the landscape changes and may lead to the land becoming a desert.

5.10 Indications and Conditions of Chemical Reaction

During a chemical change new substances are formed which are always accompanied by some external indications.

Magnesium becomes white powder on heating. In some cases, colour changes *e.g.*, rust appears as a brownish coating. When magnesium burns it burns with a brilliant dazzling light. Addition of dilute acid on zinc gives out a gas hydrogen which burns to form water — *Production of a gas*. In some cases burning of fuels produces lot of heat *e.g.*, when dilute acid is added to marble.

It has been observed that different

conditions are necessary to bring about chemical reactions in different substances.

(a) *Contact*. When sodium comes in contact with water.

(b) *Heat*. Mercuric oxide does not decompose to give oxygen unless it is heated.

(c) *Light*. Photosynthesis in green leaves takes place only in light.

(d) *Electricity*. When electric current is passed through water it decomposes into Hydrogen and Oxygen.

(e) *Pressure*. When two stones strike with each other, it produces a spark.

(f) *Catalyst*. Certain reactions can be brought about faster by using a substance known as catalyst, *e.g.*, oxygen is given off very quickly and without strong heating when you mix some manganese dioxide with potassium chlorate.

As already stated we can speed up, slow down or prevent some changes. But there are many changes over which we have no control. We cannot control the change from day to night and then from night to day or the change in seasons.

SUMMARY

1. There are different types of changes :

(i) Physical, (ii) Chemical, (iii) Slow and fast, (iv) Desirable and undesirable, (v) Periodic and Non-Periodic, (vi) Reversible and Irreversible.

2. There are indications and conditions of a chemical reaction.

3. Different conditions are necessary to bring about chemical reactions in different substances :

(a) Contact, (b) Heat, (c) Light, (d) Electricity, (e) Pressure, (f) Catalyst.

4. A change may affect a few or many properties.
5. We can control some changes for example we can prevent or slow down the spoilage of food.
6. There are many changes over which we have no control; for example Rotation of the earth.
7. We should think before we change something.

QUESTIONS

1. What are physical and chemical changes? Give two examples in each case.
2. What are reversible and irreversible changes? Give two examples in each case.
3. Give two examples of (i) Desirable and undesirable changes, (ii) Slow and fast changes, (iii) Reversible and Irreversible changes.
4. Give two examples :
 - (a) Where only few properties are affected.
 - (b) Where many properties are affected.
5. Name the different changes occurring during the following processes :
 - (1) Making models with plastercein and mud.
 - (2) Changing of milk into curd.
6. Fill in the blanks with suitable words :
 - (a) During the mid-day the shadows are and during the evening the shadows are.....
 - (b) When wood burns, it changes into and
 - (c) The appearance of some comets or of a shooting star is a
 - (d) The conversion of dead plants into manure is a..... change.....
 - (e) Coming together of two or more than two materials in all changes is called.....
 - (f) Burning of a cracker is a..... change.
 - (g) Growth of a tree is a change.
 - (h) Rotation of a fan is a.....change.
 - (i) Eruption of a volcano is a.....change.
7. Some statements are given below. Mark (✓) if the statement is true and mark (X) if it is false :
 - (a) Rusting of iron is a chemical change.
 - (b) Breaking of glass is a chemical change.
 - (c) Burning of coal is a physical change.

(d) Evaporation of water is a physical change.

(e) Stretching of rubber is a physical change.

ACTIVITIES

1. Soak a few seeds of gram or beans in a cup of water. Observe and record the change occurring in seeds every day.

2. Record all the changes that take place at or near the site at which a new building is being constructed in your locality.

3. We can prevent, or slow down the spoilage of food or the rusting of iron objects. Give other examples of changes we can control. You can take the help of your teacher.

4. You would have noticed that pineapple and bananas are often ripened inside the house after they have been plucked. Record all the visible changes that occur when a raw pineapple or a raw banana ripens.

CHAPTER VI

MOTION, FORCE AND MACHINES

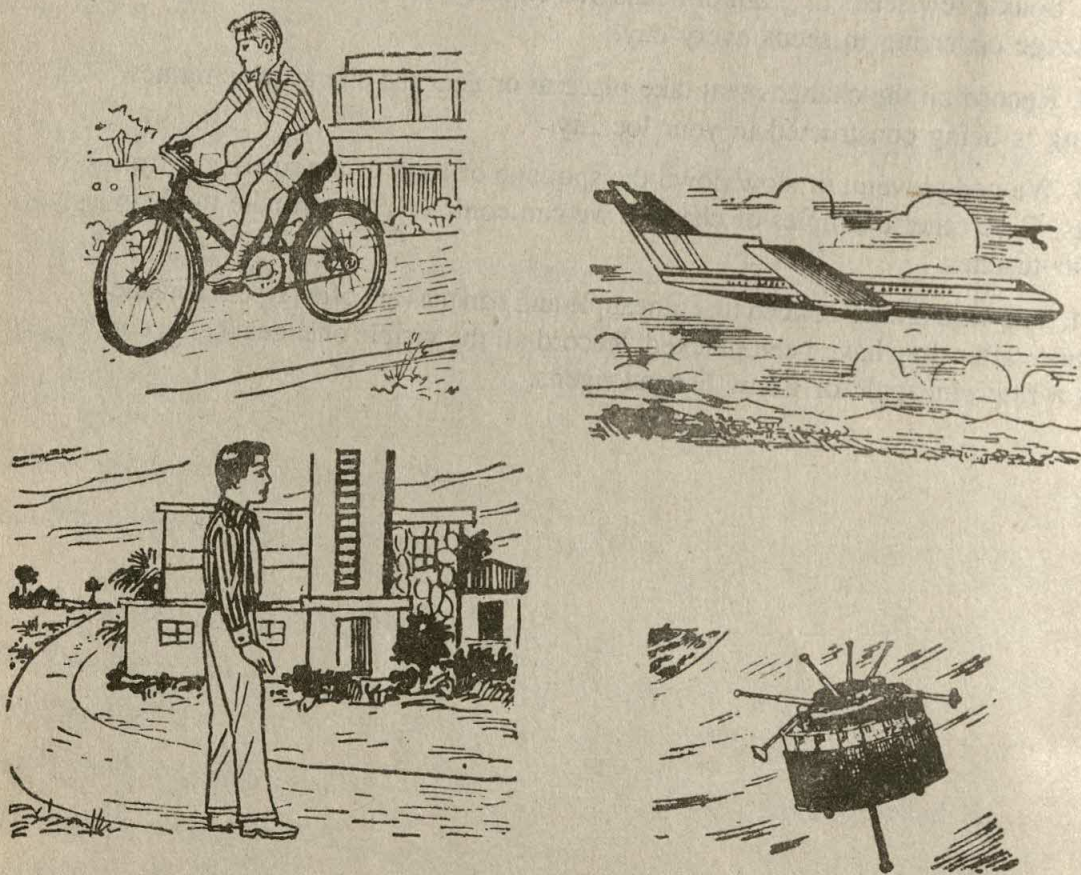


Fig. 6.1

In our daily life we see many objects moving—a man walking along a road, a boy running on the play-ground, a boy cycling, a speeding car, moving dogs and cows, a flying bird, a foot ball rolling on the ground, aeroplane flying in the air, a tiger leaping in the jungle; a satellite circling around the earth, and many other things which continually change their positions, some moving *slowly* and some others moving

fast. When you walk from your home to school or when you run on the play-ground you are in motion. Perhaps you can give a few more examples of motion from your own experience. In all these examples which we have described earlier and in several others, which you come across in everyday life, there is something common to all of them. If you observe them for a certain interval of time, they keep changing

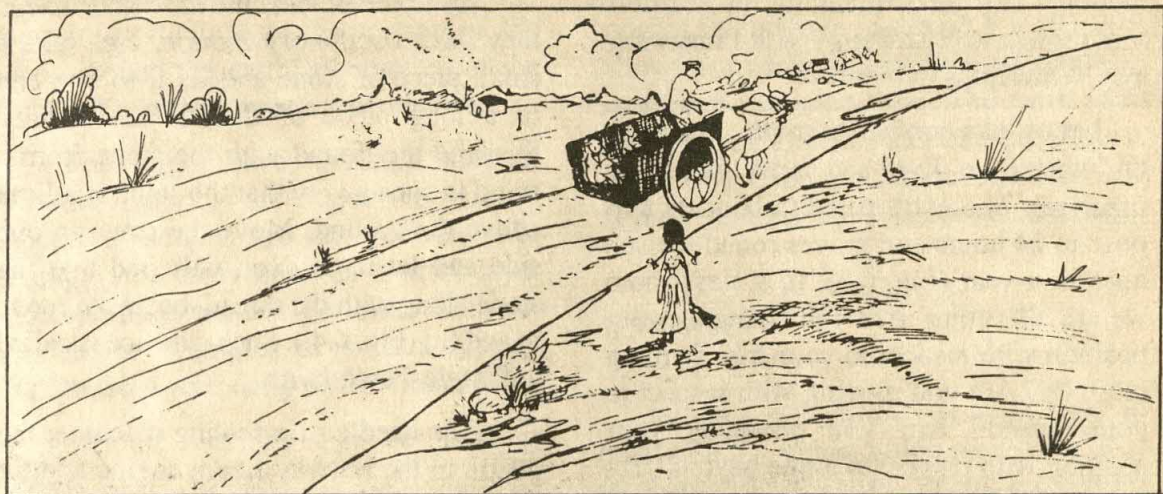


Fig. 6.2

their position. Try to think of more examples of bodies in motion. A crawling ant is continually changing its position, so also is a man who is walking. When you are asked to come to the black board you will move from your seat and walk up to the board. In this process you change your position. You will see that in all these cases an object in motion changes its position with respect to other objects. When you

walk in a room, you change your position with respect to the other bodies in the room. Thus we can say that *motion is characterised by change of position*.

Let us think of a situation. Two friends, Pranav and Vishwajit sit in a cart which starts moving while Neera stands by and watches them (Fig. 6.2). Is Pranav changing his position with respect to Neera? Will Neera say that Pranav and Vishwajit are in

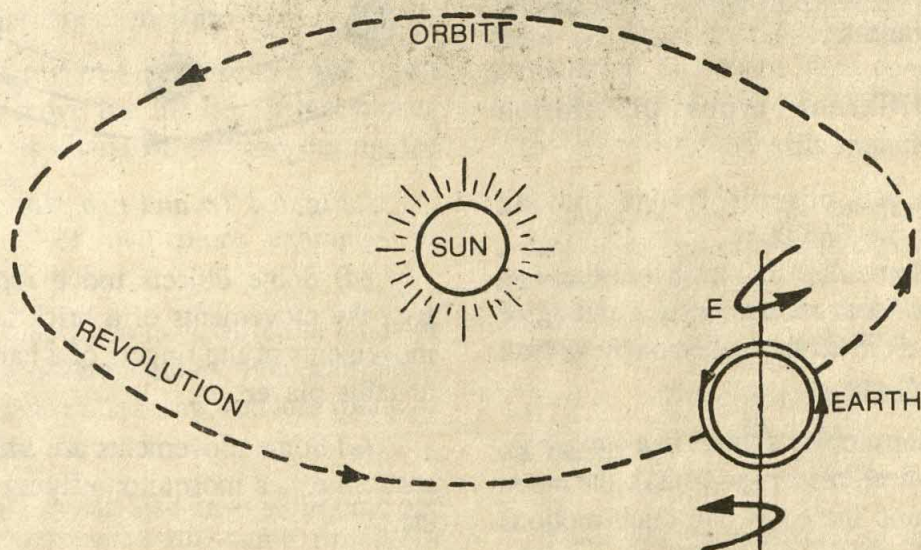


Fig. 6.3. The motion of the Earth about its axis and around the Sun.

motion? Is Pranav changing his position with respect to Vishwajit? Will Pranav say that Vishwajit is in motion?

Let us take another example. The earth on which we live and walk is nearly spherical. The earth rotates about its axis once in 24 hours and moves round the sun once in a year (Fig. 6.3). In a class room we are all sitting. Are you changing your position with respect to your friend sitting close by? Are you moving with respect to your friend? Are you changing your position with respect to a tree beyond? Do you realise that you as well as your friend and tree are all moving along with the earth? An observer outside the earth (as a pilot in a space ship) will find that you along with trees etc., are moving. Thus when you say an object is moving we imply that it is moving with respect to you. In the first example, Pranav and Vishwajit are moving with respect to Neera whereas Pranav and Vishwajit are at rest with respect to each other as there is no change in position between them. Thus you will find that all motion is relative and there is nothing like absolute motion.

6.2 Different types of Motion

(Are all Motions alike?)

When we observe things moving around us, we find that

(a) Some objects move in a line i.e., they have *linear motion*, e.g., crawling of a tortoise; a cricket ball rolled on the cricket field, light; etc.

(b) Some objects move in a circle e.g., Potter's wheel; merry-go-round; the moon moves round the earth etc. Such motions are called *circular motions*.

(c) Some objects move to and fro i.e., they have *oscillatory motion*, e.g., take a small piece of stone and tie it to one end of a long piece of thread (one metre). Suspend the thread with the stone from a stand in such a way that the stone is a little above the ground. Move the stone to one side and let it go. You will find that the stone along with the thread, begins to move to and fro (Fig. 6.4.). Such a device is called a *Simple Pendulum*.

The needle of a sewing machine; the piston in the railway steam engine and the branches of a tree in the storm etc., have to and fro motion.

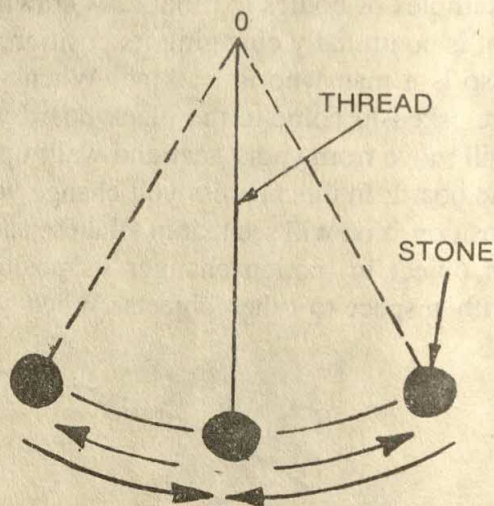


Fig. 6.4 To and Fro Motion

(d) Some objects move *repetitively* e.g., the movements of a brick layer; the movements of the fingers of a harmonium or tabla player etc.

(e) Some movements are *irregular or random* e.g., a mosquito; a flying sparrow etc.

(f) Some movements are repetitive and

take place at regular intervals of time, i.e., they are *periodic* e.g., the motion of the moon around the earth; the motion of the hands of a watch, beating of heart etc.

You might have observed that all periodic motions are repetitive but all repetitive motions are not periodic. For example, the movements of a brick layer are repetitive but not periodic. Can you give more examples of such a type of motion from your daily observations ?

Periodic motions can be used as clocks.

(g) Whenever an object changes its position, it is said to have *translational motion* e.g., a moving bus; a flying kite etc.

(h) Some objects may have *rotational motion* or *spinning motion* e.g., a rotating top, the spinning of earth around its axis etc. In this type of motion the objects can move without necessarily changing their position.

(i) Some objects have *vibrational motion* e.g., when we pluck the string of a musical instrument say sitar, its motion is called vibrational motion.

In this type of motion, the entire object does not move but the object that moves changes its shape or its size during the movement.

Think of two more examples of vibrational motion.

An object can have different kinds of motion at different times. For example, a monkey can walk, jump, run and rotate or spin.

An object can also have more than one kind of motion at the same time. For example; you must have seen famous

cricketer Bishan Singh Bedi bowling a cricket ball in a test match on T.V. The Ball shows translational as well as spinning motion at the same time. The earth spins around itself and also moves from place to place around the sun. An acrobat combines several motions when he does acrobatics.

6.3 Speed

In our daily life we see many objects moving e.g., a man going on foot; a man on a cycle; a scooter on a road; a speeding car; a moving bus; a moving train; an aeroplane flying in the air, etc. We can reach Calcutta from Delhi earlier on an aeroplane rather than going on a train. Sometimes we find it difficult to decide which of the two moving objects is moving faster. For example, one aeroplane travelled 1500 km in 3 hours, and one train travelled 240 km in 4 hours. Which of the two moved faster ? Since in 3 hours the aeroplane travelled 1500 km, it means that in 1 hour it moved $1500/3 = 500$ km. Similarly, the train travelled $240/4 = 60$ km in one hour. Thus it is very clear that the aeroplane travelled faster than the train. Here we have calculated the distance travelled in one hour. This concept that relates distance to time in the study of motion is called *speed*.

Speed is the ratio of the distance travelled by any object, irrespective of its direction, to the time it takes to travel that distance. In other words, it is the distance covered by a body in a unit time.

$$\text{Speed} = \frac{\text{Total distance travelled by a body}}{\text{Time taken}}$$

Since the standard unit of distance is metre and the standard unit of time is

second, therefore, the unit of speed is *metre/second* or *m/s* or ms^{-1} (Read it as metre per second).

For the sake of convenience, other units of speed are also used. They are :

(i) centimetre/second written as *cm/s* or cms^{-1}

(ii) metres/minute written as *m/min* or $m\ min^{-1}$

(iii) kilometres/hours written as *km/h* or kmh^{-1}

6.4 Force

We can make things move in a variety of ways. For example, you can *push* an object or *pull* it.

Activity

1. Take two magnets and hold one in each hand. Bring one end of one magnet near one end of the other. What do you feel?

Take one magnet away, turn it round and bring its other end near the same end of the second magnet. What do you feel now ?

Place one of the magnets on the table, hold the other magnet above it and gradually lower it. Do you feel the magnets pushing or pulling each other ?

2. Hold a brick and support it on the palm of your hand. Do you feel the brick pressing down on your palm ?

3. Look at the three pictures (Fig.6.5) in which a boy is trying to compress and stretch a spring. In which of the three pictures do you think he is feeling, (i) a push, (ii) a pull ?

Try this experiment yourself using a

similar spring and find out if your guess is correct.

In the above experiments when one feels a push or a pull, we call it a force.

Effects of force

Object can be moved by living agents like man or other animals or by non-living agents like wind or water. For example, push a ball along a floor, it starts rolling, we use camels to pull carts in the deserts, water falling from a height is used to turn a generator which produces electricity.

We can also make some moving objects stop. For example, we stop a moving bicycle by applying brakes. A fielder in a cricket field stops a moving ball with his hands.

Force can change the shape of an object. e.g., the shape of a balloon changes on pressing; the shape of a spring changes on pulling; the shape of a banana changes on pressing etc.

We observe that the push or pull may have several different effects :

(i) It makes the body move slower or faster *i.e.*, changes its speed.

(ii) It stops the body if it is moving.

(iii) It moves the body if it is not moving.

(iv) It changes the direction in which the body is moving *e.g.* hold your hand firmly at an angle to a moving ball in its path. You will notice that the direction of the moving ball changes.

This action is often employed while playing cricket.

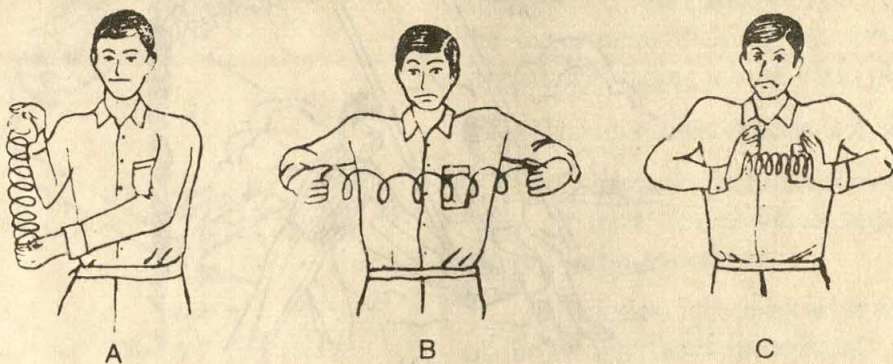


Fig. 6.5

(v) It changes the size and shape of an object.

Thus whenever we wish to change the motion of an object, we have to do something to the object. In every cases we have to exert a *force* on the object to change its motion.

Thus *force is that push or pull which moves an object from rest or makes an object move faster or slower or brings it to rest or changes the direction of a moving object or changes the size and shape of an object.*

Types of Force.

Forces are considered to be mainly of two types :

- (a) contact forces (visible forces)
 - (b) action at a distance (invisible forces)
- (a) **Contact Forces (Visible Forces)**

Contact force is caused when the molecules of one body come in contact with those of another. They can be transmitted

only through solids, liquids and gases. They may be classified according to their phenomena such as :

- (i) Mechanical force or *Muscular force*
 - (ii) Frictional force
- (b) **Action at a distance (Invisible Force)**

We can have pushes and pulls without an intimate contact. This can act through space and does not require one thing to touch another. These can be classified as :-

- (i) Gravitational Force
- (ii) Magnetic Force
- (iii) Electrical Force

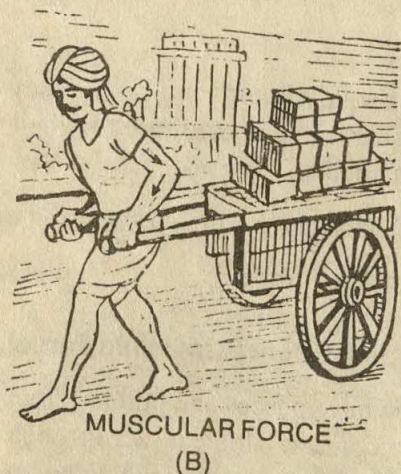
A force cannot be seen but one or more of its effects are observed or felt.

Muscular Force

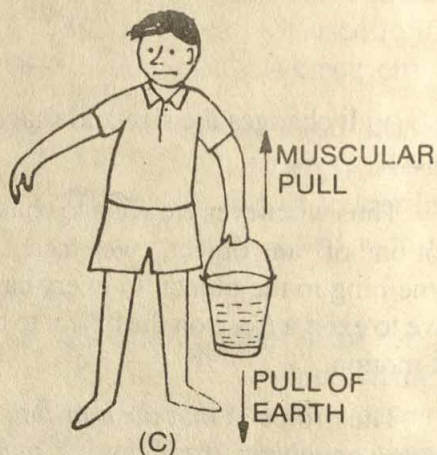
To lift a bucket full of water, some force is required. When you lift it by hand, the force is exerted by the muscles of your arm. The force exerted by the muscles is called *muscular force*. Both animals and human beings exert muscular force to do work (Fig. 6.6.).



(A)



(B)



(C)

Fig. 6.6 Examples of Pull or Push

Frictional Force

If you push a ball on the playground, it rolls forward. However, it gradually slows down and comes to rest even if you do not stop it. Is there any other force responsible for this?

There are forces which slow down the movement of the objects. A force of friction is one of them. The following activities will show how friction acts in solids, liquids and gases.

Activity

Take a big table. Give it a small push.

Does it slide? If not, increase your push. Do you succeed in pushing the table? May be you do not. Try to pull the table. What do you experience? Why do you find it difficult to slide the table over floor? Is that there is some force opposing the force of your pull or push? In fact there is a force which opposes your pull and is acting in a direction opposite to that of your pull. If your pull is smaller than the opposing force, the table will not slide at all. But when a sufficiently large push or a pull is exerted so as to balance the opposing force, the table will slide.

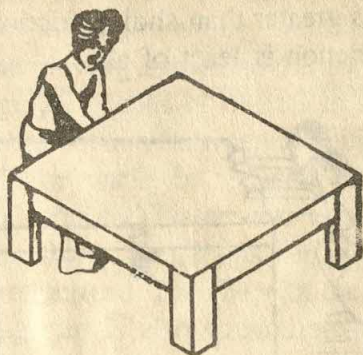


Fig. 6.7

Activity

Drop some ball bearings through a tall jar of water and also through a jar of glycerine. What difference do you observe? Will the balls have the same motion through air as through water?

Activity

Hold a piece of paper vertically by the top edge and move it slowly and then quickly through the air. What do you observe?

Solids, liquids and gases all tend to stop things moving in or over them. They all exert opposing forces. This opposing force is called *friction* or *frictional force*.

Gases offer less friction than liquids and liquids less than solids.

It is a common experience that an empty box can be moved more easily than one which is full of clothes, even if the floor is the same.

Roll a glass marble and a wooden ball, with the same force, on the same top of a long table. Now make the top surface of the table different by spreading a lot of sand on it and repeat the experiment. You will

notice that the balls bog down in the sand and come to rest quickly. You may repeat the experiment making the surface very smooth by placing a long glass plate on it.

These common experiences show that :

(a) when an object moves over another there exists a force which opposes the motion and is called friction.

(b) friction increases with roughness of the two surfaces in contact.

(c) friction increases with weight of the object when surfaces are the same.

Friction produces heat. For example rub your hands and you will feel the heat produced by friction. When you pump air into the bicycle tyre, the friction between the moving air and the walls of the nozzle produces heat and warms up the nozzle. When a shooting star enters the earth's atmosphere, the friction between the shooting star and the air produces so much heat that the shooting star melts and evaporates and hence appears bright.

Friction is an evil in life because it causes wear and tear. Parts of machinery wear out easily because of friction, and a lot of fuel is wasted in driving objects while overcoming friction. Friction and hence wear and tear in moving parts of machinery, is effectively reduced by *making the surfaces smooth*. This can be done by applying grease or oil in them or by using ball bearings *i.e.*, small smooth steel balls. Applying of grease or oil is called *lubrication*.

Friction, however, is a necessity in life as well. It prevents vehicles from skidding and enables us to walk without slipping. When brakes are applied to stop a

bicycles etc., they cause friction to be produced which opposes the motion. Fibres made of ropes cannot hold together without friction. *Friction is increased by making the surfaces rough.* That is why sand is sprinkled on the railway lines on the mountains when it snows.

There are different forms of friction. These are :

- (i) Starting friction
- (ii) Sliding friction
- (iii) Rolling friction

Force required to start a body moving gives us the measure of starting friction and the force required to keep the body moving gives us the measure of sliding friction. When a cart or a trolley is moving on the ground, rolling friction comes into play. You will learn more about these kinds of

friction in your higher classes. Starting friction is greater than sliding friction and rolling friction is least of all.

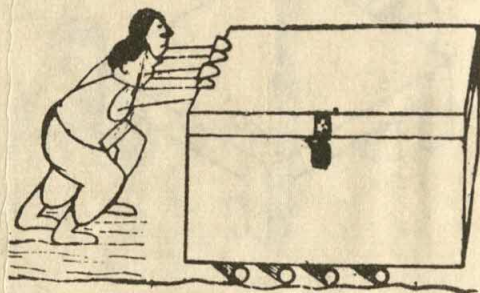


Fig. 6.8 Rolling Friction

Streamlining

Have you ever seen a swimmer diving in a swimming pool? When he dives, he lets his hands enter the water first followed by his head. Water offers less friction to pointed objects than to flat ones. For the

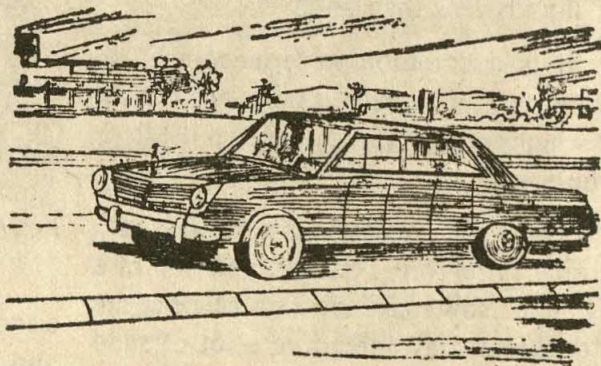
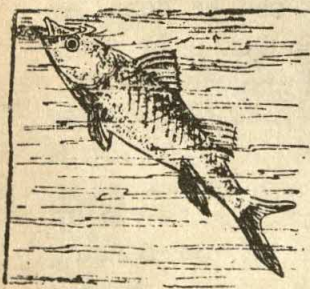
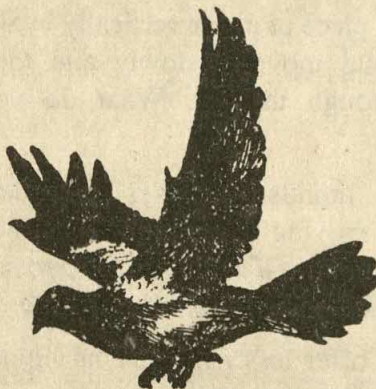
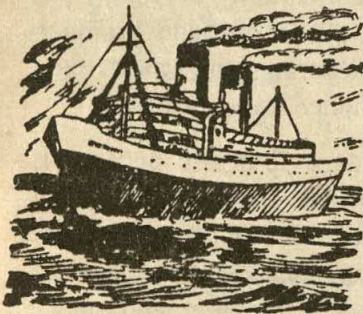


Fig. 6.9 Streamlining of objects

same reason an arrow is fitted with a pointed tip so as to reduce the friction between the moving arrow and the air. We often design the shapes of objects in such a way that the friction between the objects and the air or water is reduced in the direction of motion. This process is called *streamlining*. Boats, cars, trains, aeroplanes, ships are streamlined. The shape of the fish and a flying bird is also streamlined.

Magnetic and Electric Forces

Activity

Place a few iron nails on a table. Take a magnet and bring it close to the nails as shown in Fig. 6.10.

What do you observe? Why are the nails pulled towards the magnet? Now bring an iron bar near the nails. What do you observe? Try this with bars of other materials like copper or brass. Do they pull the nails?

You will see that only a magnet exerts a force on the iron nails and pulls them. This pull is, therefore, called the *magnetic force*.



Fig. 6.10 Magnetic force

Activity

Take a glass rod and some tiny bits of paper. Place the bits of paper on the table. Take a piece of silk and rub the glass rod with it. Bring the glass rod close to the bits of paper. What do you observe? Take another glass rod without rubbing it with the silk and bring it near the bits of paper. What do you observe?

Now take a comb or a pen and rub it briskly on your hair, or a piece of wool or silk or nylon and bring them near the bits of paper. What do you observe? (Fig.6.11)

You will find that when objects like glass rods, combs or pens are rubbed, they get an electric charge. These objects are called charged bodies. The force which a charged body exerts is called the *electric force*.

Gravitational Force; Weight

The most familiar of all forces acting at a distance is that of gravity. It is the force with which the earth pulls an object towards itself.

Everyone on the earth, and every

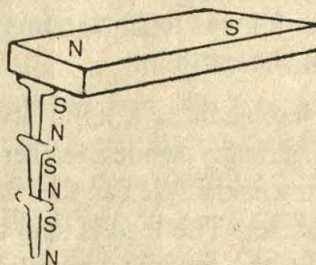




Fig. 6.11

object that we see, experiences the force of gravity. It is such an important force that we give it a special name *Weight*.

The weight of an object is the force by which the earth pulls it towards itself. This force, therefore, always acts downwards.

To people in India and America, falling objects move in opposite directions because each object is pulled towards the centre of the earth. It is not only the earth which exerts a pull on things, in fact every object attracts every other object, but unless one of the objects is huge, like the earth, the attractions are negligible. You are attracting your neighbour and he attracts you but both forces are small compared to the force of the earth.

An object each as a lump of lead is pulled down strongly, while a feather is only pulled down weakly. We can feel this with our arm muscles. The lead is said to have a big weight, the feather a small weight. Weight or pull of the earth on an object is a property of all matter, whether it is solid, liquid or gas.

The weight of an object is not the same at every place on and around the earth. For example, your school bag is pulled more by the earth at sea level than it is on the top of a high mountain and so its weight is greater at sea level. This is because as the distance from the centre of the earth increases, the force of the pull of the earth, that is weight, decreases. Under certain conditions the weight of an object (the downward pull by the earth) can be made zero, the object is then said to be *weightless*.

On the Moon, the pull on an object is due to Moon. The Moon is much smaller than the earth. An astronaut or any object will therefore, weigh much less on the moon than on the earth.

Measurement of Forces and Unit of Force

A small force may not produce any visible change but a large enough force often produces an effect that we can notice. For example; a small wind force may cause mere rustling of leaves, a large force may cause movement of branches. The force of

wind during a storm may even uproot trees. Bridges have been broken by the force of river waters during floods.

Activity

Take a piece of ordinary thread and break it. Now, take six pieces of ordinary threads together and try to break these. What do you experience?

So far we have discussed about large and small forces. But how do we measure the forces? Forces are measured in comparison with standard forces.

The force with which the earth pulls a mass of 1 kg towards itself is called 1 kilogram force or kilogram weight (kg wt). About one-tenth of this force is named 1 newton.

Hence 1 kilogram weight = 10 newton

Thus the units of force are kilogram weight and newton.

Activity

Hold a kilogram mass in your hand. You are now feeling a force of 1 kg wt. If you keep a 100 gram mass on your palm, you will feel a force which is 100 gram-force and which is very nearly equal to 1 newton.

Spring Balance

One of the simple instruments used to measure force is the *spring balance*.

Activity

Cut about one metre of open copper wire (SWG 10). Make a spring by winding it round a pencil twenty five to thirty times.

Form a twisted loop at each end. Hang the spring by one loop from the clamp in a retort stand as shown in Fig. 6.12.

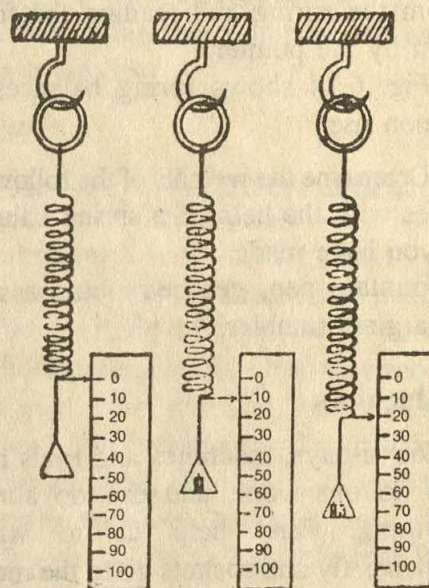


Fig. 6.12

Stretch the spring by adding 10 gram weight and measure the increase in length, marking it on a scale. Go on adding ten gram weights everytime upto a certain limit and record it on the scale.

In this activity with a spring you will have noticed that if you hang two equal loads from a spring, the extension in the spring is twice as much as produced by a single load, and three times the force will produce an extension three times. When the loads are removed, the spring returns to its original length. This serves as a simple basis for constructing a spring balance to measure forces.

To construct a spring balance, standard

weights are hung from a spring and the extension recorded on a scale with the help of a pointer.

The scale is thus *calibrated*. An unknown load can be measured by hanging it from the spring and reading the force shown by the pointer.

Fig. 6.14 shows spring balances in common use.

Determine the weights of the following articles with the help of a spring balance that you have made.

Fountain pen, geometry box, a steel ball, a glass tumbler.

6.5 Machines

Now-a-days, machines and tools help us to do our work, and can do almost everything. Pens help us to write, aeroplanes fly and rockets go to the moon.

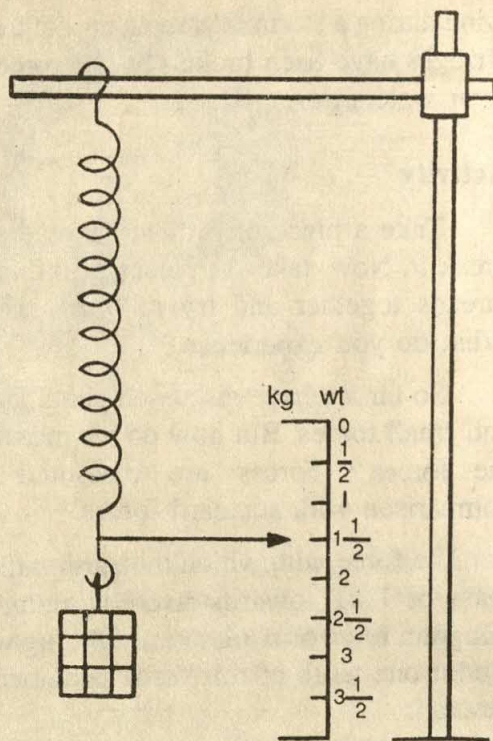


Fig. 6.13

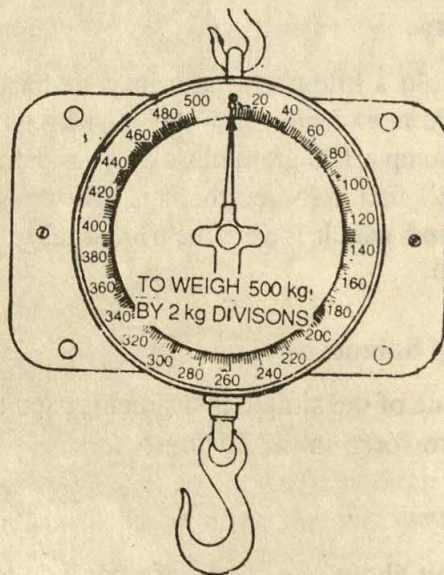
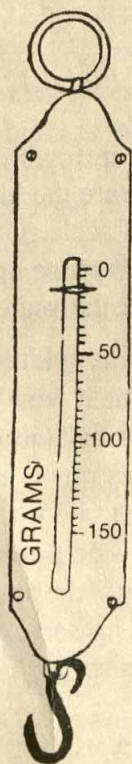


Fig. 6.14

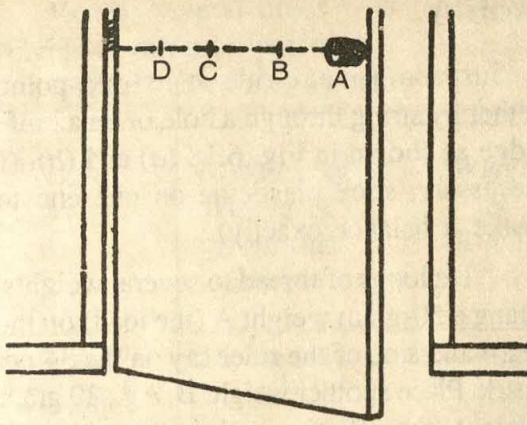


Fig. 6.15 Pushing a door

A hammer, pair of scissors, a wheel barrow etc., are simple machines. A printing press, jet aeroplane, huge crane, a dynamo in the power house etc., are large machines. When you hold something in your hand you are using your arm, which is in fact, a type of machine. When you are opening a bottle, the instrument that you are using is a machine.

Thus we may think of a machine as a device which helps us to do work more easily and more conveniently than could be done by hand.

Relationship between Force and Distance

Let us start by carrying out the following simple activities :

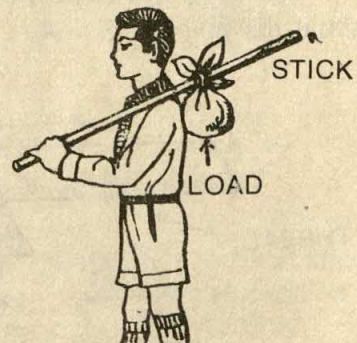
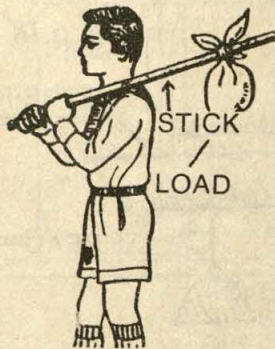


Fig. 6.16

Activity

Open a door and then close it by pushing it with one finger near the door handle A (Fig. 6.15). Then close it again by pushing it with one finger in turns at points B, C and D as shown in Fig. 6.15. At which of the four points was it easiest to push the door ?

Activity

Tie a load to the end of a stick and rest the stick over your shoulder while holding the other end A as shown in Fig. 6.16. Start with load as near the shoulder as possible, and the first end will then be as far from the shoulder as possible. Gradually slide the stick over your shoulder, increasing the distance between the load and your shoulder and thus reducing the distance of your hand from your shoulder. In which position did you find it easiest to carry the load ?

You will have found that the door is closed most easily when the hand pushes at a point *farthest* away from the hinges and that the load on the stick is carried most easily when the load is *nearest* your shoulder and your hand *farthest* from it. Thus, in general, *you will have found that the farther the hand is from the turning*

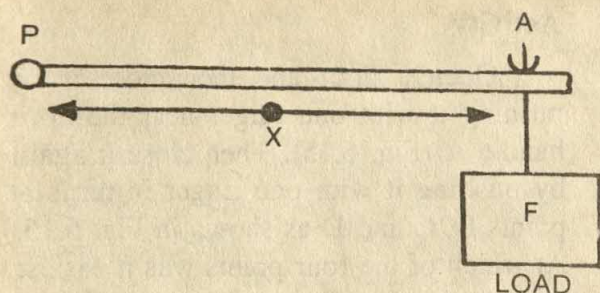


Fig. 6.17

point, the easier it is to achieve the task required.

We shall call the thing being carried or lifted the *load*, the force with which it is carried or lifted, the *effort* and the point about which the turning takes place the *fulcrum* or the *pivot*. Using these terms to express the results of your activities, we can say that *the load is most easily overcome when we apply the effort as far away as possible from the fulcrum*. The 'Turning effect' of a force depends on how large the force is and also on how far the force is from the fulcrum or the pivot. *This turning effect of a force about a fulcrum is known as moment of the force about the fulcrum and is measured by the product of the force and its perpendicular distance from the fulcrum*. For example, in Fig. 6.17 F is a load or force applied at a distance 'X' from the fulcrum or pivot P. The moment of the force F about the pivot is $F \times X$.

Activity

Suspend a metre-rule at its mid-point, either by string through a hole or on a knife edge as shown in Fig. 6.18 (a) and (b). (If necessary, stick plasticine on one end to make it balance exactly).

Tie loops of thread to several weights. Hang a 50-gram weight A (the load) on the left-hand side of the ruler say on the 34 cm mark. Place another weight B, e.g., 20 gram weight (the effort), on the other side and move it until the ruler balances. Note the distances of the weights from the fulcrum i.e., from the mid point.

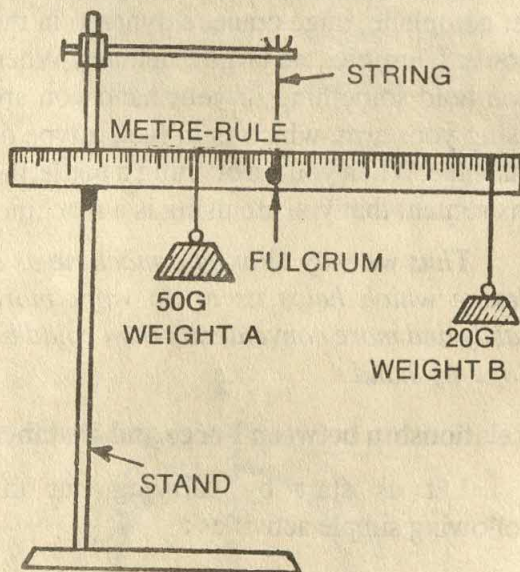


Fig. 6.18 (a)

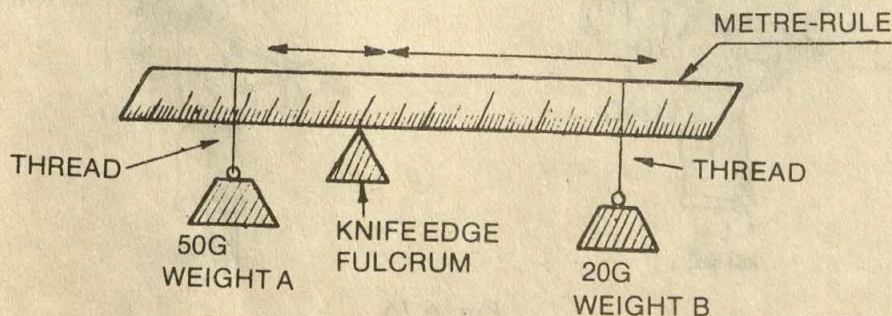


Fig. 6.18 (b)

Repeat several times with the same weights in different positions.

Record the results as below :

the two distances from the fulcrum known as *arms* are equal. So in balanced conditions, the load must be equal to the

Weight A	Distance of Weight 'A' from the fulcrum	Weight × distance	Weight B	Distance of weight B from the fulcrum	Weight × distance
50 gm	16 cm (say)	800	20 gm	40 cm (say)	800
50 gm			20 gm		
50 gm			20 gm		
50 gm			10 gm		
50 gm			20 gm		

Compare the third column with the sixth column. From this activity you can see that a small force applied at a point far away from the fulcrum can move a large load placed near the fulcrum. That is why a crowbar is useful for shifting heavy loads. Can you explain why a spoon is useful in opening the lid of a can? Where do you think is the fulcrum in this case?

When we wish to compare the weights of two objects, we make use of a device

known as *beam* balance (Fig. 6.19). Here effort, *i.e.*, the two objects placed in the two pans are of equal weight.

Principle of Work

Work done on a machine is called *Input* and the work done by the machine is called *output*. If it is an *ideal or perfect* machine *i.e.*, there is no loss of work done on it due to friction, heat, sound etc., then

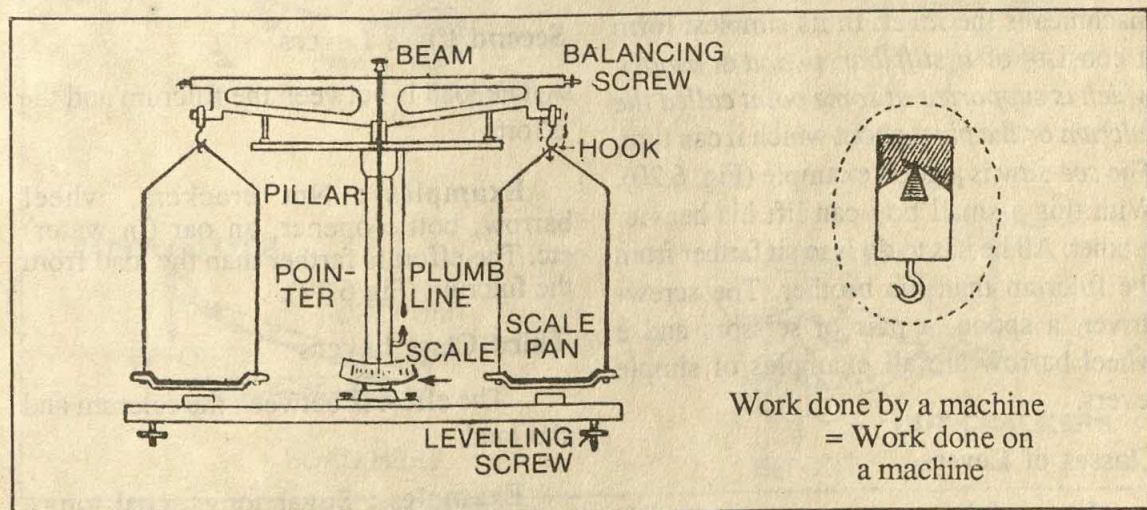


Fig. 6.19

This is known as principle of work as applied to a machine.

Efficiency of a machine

$$= \frac{\text{Work done by a machine}}{\text{Work done on the machine}}$$

In a perfect machine, efficiency is 100% but in all practical machines, work done by the machine is less than work done on it and hence efficiency is *less* than 100%.

Simple Machines

We use many machines in our daily life; some complicated, and others so simple that their working can be easily understood. The complicated machines are generally made up of several *simple machines* working together. The simple machines are :

- (i) Lever
- (ii) Pulley
- (iii) Wheel or Gears
- (iv) Inclined Plane
- (v) Screw

(i) Lever

The commonest and simplest of all machines is the *lever*. In its simplest form it consists of a *stiff bar (wood or metal)* which is supported at some point called the *fulcrum* or the *pivot* about which it can turn. The *see-saw* is a good example (Fig. 6.20). With this a small boy can lift his heavier brother. All he has to do is to sit farther from the fulcrum than his brother. The screw-driver, a spoon, a pair of scissors and a wheel barrow are all examples of simple levers.

Classes of Levers

Levers fall into three classes according to whether it is the fulcrum, the load

or the effort which is between the other two.

First Class Levers

The fulcrum is between the load and the effort.

Examples : Beam or lever of a balance, crowbar, scissors, see-saw, wire cutter, claw-hammer (used to pull nails out of wood), steelyard, etc. (Fig. 6.21).

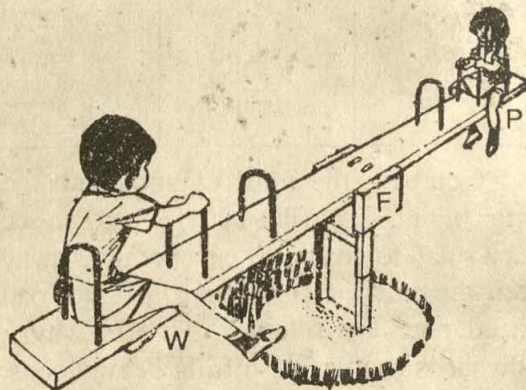


Fig 6.20 See saw

To make work easier, the effort should be farther from the pivot than the load.

Second Class Levers

The load is between the fulcrum and the effort.

Examples : Nut crackers, wheel barrow, bottle opener, an oar (in water) etc. The effort is farther than the load from the fulcrum (Fig 6.22).

Third Class Levers

The effort is between the fulcrum and the load.

Examples : Sugar tongs, coal tongs, fishing rod, forceps, spade, arm, etc. Fig. (6.23).

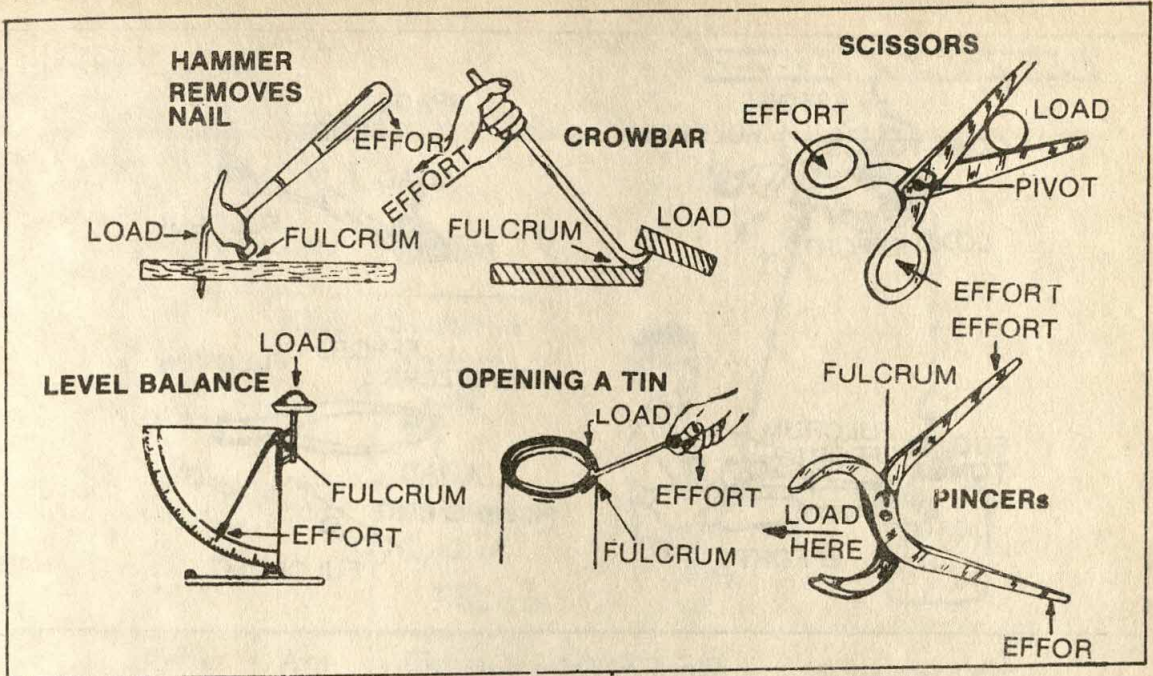
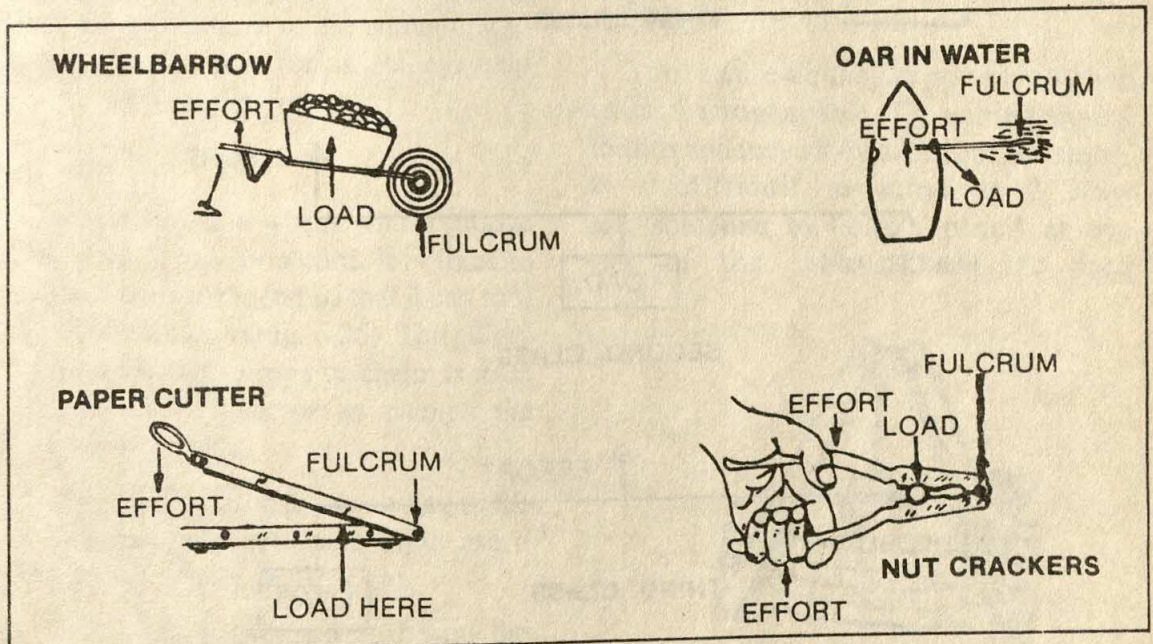


Fig. 6.21 First class levers

Here the load is farther than the effort from the fulcrum. Have you ever experienced any difficulty in picking up the small

weights of a chemical balance using a pair of forceps or picking up a lump of sugar with a sugar tongs?



6.22 Second class levers

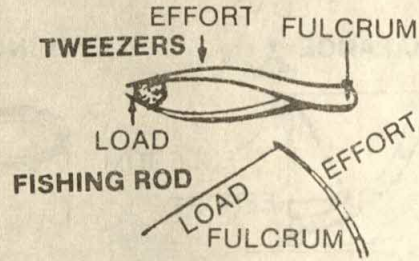
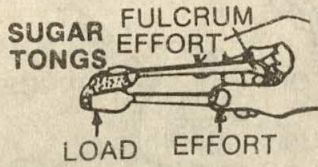
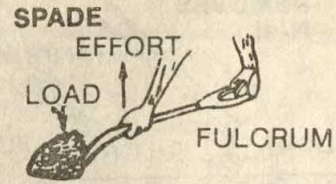


Fig. 6.23 Third class levers

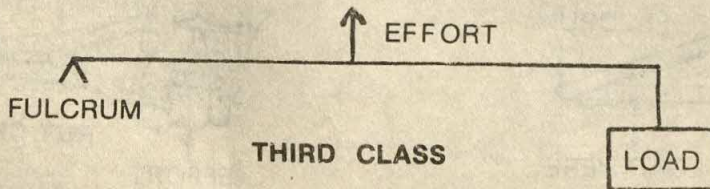
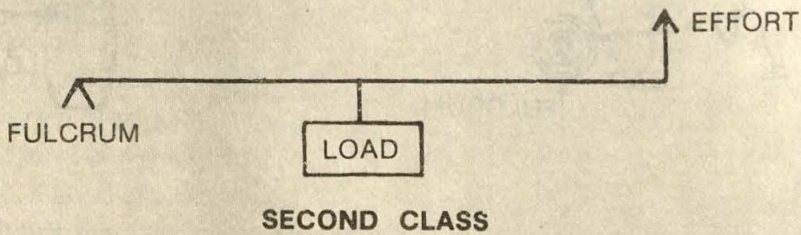
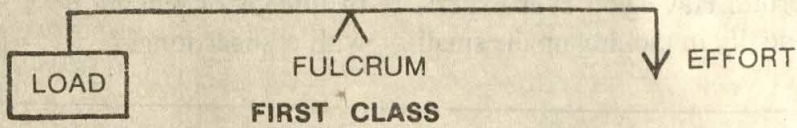


Fig. 6.24 Three Kinds of Levers

Levers in the body

Examples of the three classes of levers occur in the body :

	Fulcrum	Load	Effort
Head	Joint between head and back bone	Head	Muscle at back of neck
Foot	Toes	Body	Calf muscle (back of leg)
Arm	Elbow	Arm	Biceps muscle (Upper arm)

Sometimes we find that a piece of work cannot be done by us because the load is too heavy. We have to use something to make the work easier for us. Pulleys help to make work easier for us.

(ii) Pulley

The pulley is a wheel with a groove which holds a rope or a cord. It is fixed to a block of wood or metal so that it can turn freely about its axis (Fig. 6.25). The pulley used together with a rope or chain, is used to lift heavy weights or to change the direction of a force.

The pulley is used to raise a flag to the top of a flag pole. Builders often use a pulley to lift bricks, cement etc.

It is more convenient to be on the ground and to pull downwards than to pull upwards.

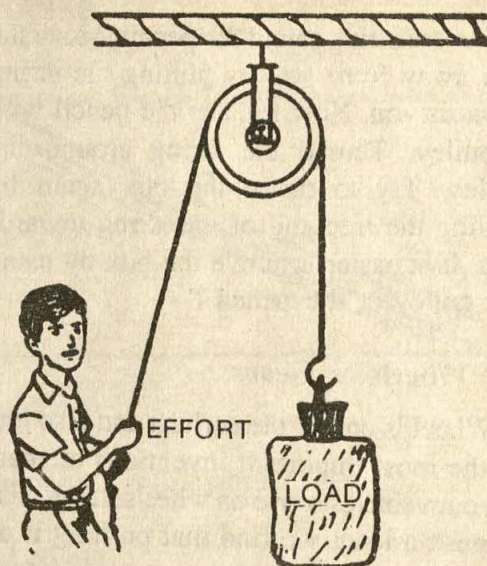


Fig. 6.25 Simple Pulley

Fig. 6.26 shows another use of a pulley in drawing water from a well.

Activity

You can use a pulley to pull a heavy box of sand across a table. Tie a string around the box and move it by pulling on the string. Is it difficult to move it ? Now ask someone to hold a pencil at one end of the table. Loop the free

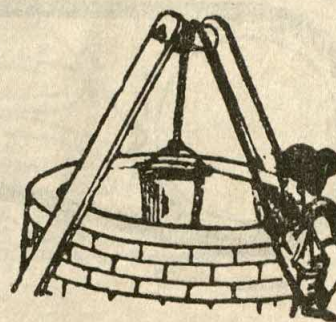


Fig. 6.26

end of the string round the pencil. Move the box away from you by pulling the string towards you. Now replace the pencil with a pulley. Thread the string around the pulley. Try to move the box again by pulling the free end of the string towards you. Is it easier to move the box by using the pulley or the pencil?

(iii) Wheels or Gears

Wheel is one of the earliest and also one of the most important inventions of man. All our vehicles move on wheels. If we wish to push a load, we find that pushing it on wheels is always easier.

Gears are wheels that are used in many machines to transfer circular movement or *rotation* from one part to another. Most wheels are used in pairs. Some wheels have toothed edges while others do not. There are two ways of making both wheels turn. One way is by the use of a belt around the wheels which have smooth edges (Fig 6.27). The other way is by fitting the teeth of the two wheels together as shown in Fig 6.28.

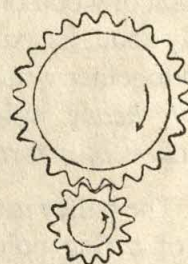
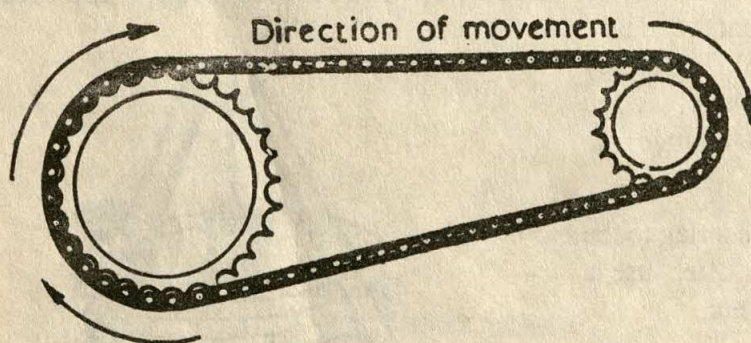


Fig. 6.28

Fig. 6.27 Toothed wheels fitted together

Activity

Take a bicycle and turn it upside down. Slowly turn its pedals. How do the wheels and pedals turn? How many times does the back wheel turn for one turn of the pedals.

(iv) Inclined Plane

Lean two smooth planks, one twice as long as the other, against a box about 1 metre high (Fig. 6.29). Pull the same load up each plank and note the forces required by using spring balances. The force needed to pull the load up the long plank is half of that required for the short one.

If a man wants to place a load, say a full drum of oil on the floor of a truck, that is say one and a half metre above the road, by lifting it, it will not be easy for him to do so. It is much easier if he uses a strong plank of wood with one end on the back of the lorry. The plank makes a *slope or inclined plane which is a machine*.

Examples of inclined planes are *staircases* used for climbing up clock-towers or light-houses, and *roads* that wind

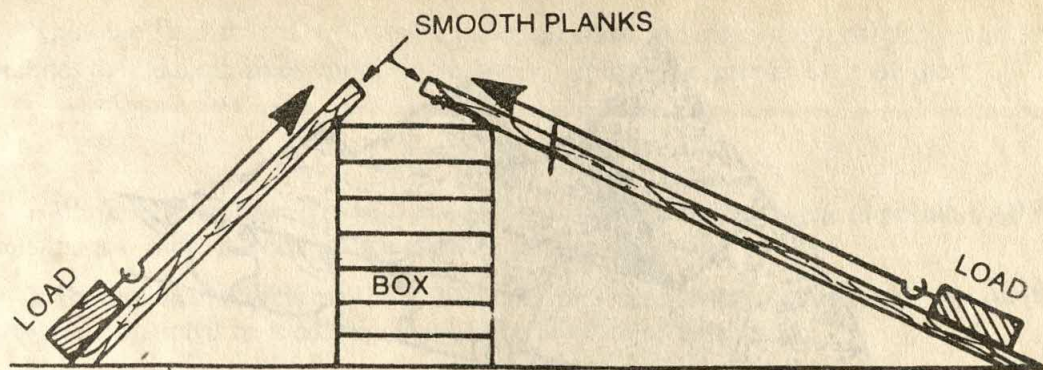


Fig. 6.29 Inclined planes

their way up steep hills (Fig. 6.30). Nagas feel it difficult to climb up and climb down a hill in the absence of such winding roads.

It is supposed that Egyptians used inclined plane method to pull heavy stones to great heights in building their famous pyramids. (Fig. 6.31).

(v) The Screw

Screws and bolts are used to join together with great force two pieces of wood or metal. Motor car jack Screws and Vices use the principle of the Screw and are used to lift cars and other heavy objects.

A screw is an inclined plane wrapped

around a rod, cylinder or pole.

Activity

Take a piece of thick, square paper, 10 cm long. Cut it along a diagonal so that you have two triangles. Take one of the paper triangles and colour its longest edge. Now wrap this paper about a pencil as shown in the diagram. What have you made? How does the coloured edge of the paper appear on the pencil?

When a screw is turned once round, it advances a distance equal to the space between two neighbouring threads. The distance is called the *pitch* of the screw.



Fig. 6.30 A winding road in an inclined Plane

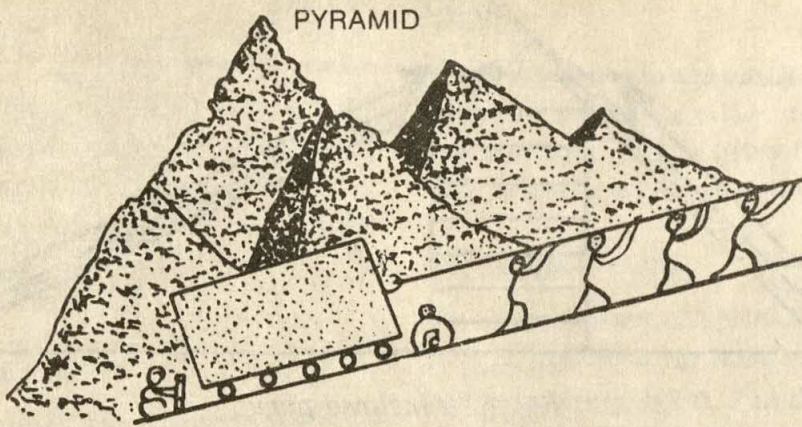


Fig. 6.31 The Pyramids

You will find that it is more difficult to get screw with bigger pitch into a piece of wood than a screw with a smaller pitch. Can you explain why?

The five simple machines discussed above are like letters of an alphabet, out of which more complex machines are made, just as A, B, C.....are the letters of the alphabet out of which words are made in the English language. For example, Motor Jack Screw is a two letter word in the language of machines, and the two letters are screw and lever. Examine a bicycle and see how many simple machines you can identify in it.

Proper Care of Machines

We have already learnt that friction opposes motion and that lubrication reduces friction. We should, therefore, lubricate the moving parts of a machine. Oiling the various parts of a bicycle or a sewing machine will reduce friction and make the task much easier.

We can prolong the life of the machines by painting the various parts and thus preventing them from rusting.

Machines must be protected from dirt and dust to reduce wear and tear. When a machine is not in use, it should be covered.

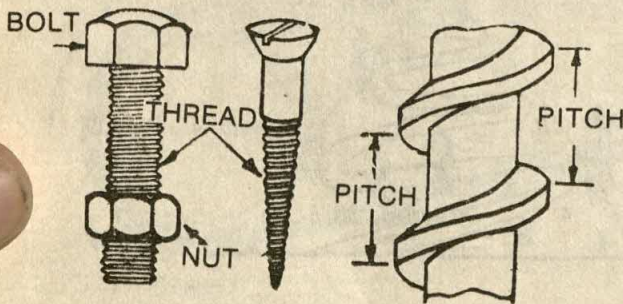


Fig. 6.32 The Screw

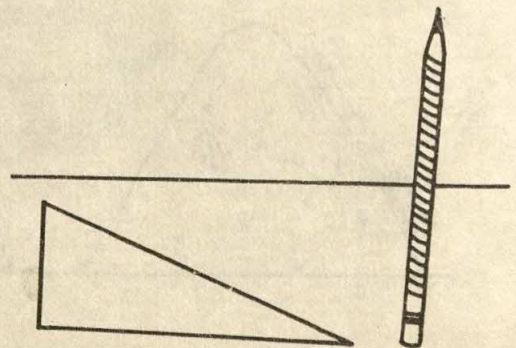


Fig. 6.33

Thus we find that if we wish to use machines to make our lives comfortable, we must maintain them properly and also we must take proper care of them.

SUMMARY

1. We observe motion all around us. Motion is characterised by change of position. All motion is relative and there is nothing like absolute motion.

2. The motion of objects may be of different types—translational, rotational, circular, oscillatory, repetitive, vibrational or a combination of one or more of these types.

3. Some objects may have more than one type of motion at the same time.

4. Force is that pull or push which produces or tends to produce, destroys or tends to destroy motion in a body.

5. A force is absolutely *necessary* to bring about a change in the motion of an object. The change can be of four types:

- (i) The speed (distance/time) of the object may change.
- (ii) The direction of the movement may be changed.
- (iii) Both the speed or the direction may be changed.
- (iv) The shape and size of an object may be changed.

6. Force is measured in kilogram weight and newton.

7. There are two types of forces:

- (i) Contact Forces—Mechanical force and Frictional force.
- (ii) Action at a distance—Gravitational force, Magnetic force, Electrical force.

8. Whenever one body moves over the surface of another body an opposing force called friction is called into play.

9. Friction can be reduced by making the surfaces smooth i.e., by using lubricants etc., or by using rollers. It can be increased by making the surfaces rough. Friction produces heat. Rolling friction is the least of all the types of friction.

10. Pull of the earth on the body is called its *weight*. Weight is, therefore, a force.

11. Force may change the shape of an object. This property can be used to measure force, as in a spring balance.

12. A *machine* is a device that helps to do work more easily and more conveniently than could be done by hand.

13. *Load* is a thing which is carried or lifted by a machine.

14. The force with which the load is carried or lifted by using a machine is called the *effort*.

15. Load is most easily overcome when we apply the effort as far away as possible from the fulcrum or pivot.

16. Work done by the machine = Work done on the machine. This is called the *Principle of work* as applied to a machine. This principle holds good in case of a perfect or ideal machine only.

17. Complicated machines are generally made up of the following simple machines:

- (i) Lever
- (ii) Pulley
- (iii) Wheels or Gears
- (iv) Inclined Plane
- (v) Screw

18. We must take proper care of machines by lubricating or oiling the various parts etc., so as to reduce friction.

QUESTIONS

1. (a) What is motion ?
(b) Name different types of motion and give two examples of each.
2. (a) Define force. Give three examples of force.
(b) Name the various effects of force. Give one example in each case.
(c) Give the unit of force.
3. What makes things, that are stationary, move or things that are moving stop ?
4. Can we control motion ? If so, how ?
5. What force do the following demonstrate :
 - (i) Attraction of hair by a comb
 - (ii) Forming a small drop of water
 - (iii) Dropping of a ball
 - (iv) Movement of the ball on the ground
 - (v) Throwing a stone
 - (vi) Drawing water from a well
 - (vii) Movement of branches of trees
 - (viii) Attraction of iron particles by a magnet

Select proper words from the list of phrases given below :

Muscular force; mechanical force; molecular force; electrical force; force of wind; force of gravity; frictional force.

6. What is friction ? Name various types of friction.
7. Why is friction necessary in life ?
8. Why is friction regarded as an evil ?
9. How can we increase and decrease friction ?
10. What is streamlining ? Why are cars and ships streamlined ?
11. What is that thing which enables a fish to move easily in water ?
12. What is a spring balance ? Define weight of a body ?

13. A bus covers a distance of 100 km in 2 hours. What is the speed of the bus (a) in kilometre per hour and (b) in metre per second?
14. A person riding a cycle moves a distance of 20 m in 50 seconds. What is the speed of the cyclist?
15. A girl is sitting in a moving merry-go-round. What type of motion is she having?
16. Classify the following as linear, circular and oscillatory motion.
 - (i) The motion of a cyclist on a straight plane road.
 - (ii) The motion of a plucked string of a sitar.
 - (iii) The motion of the tip of the hand of a clock.
 - (iv) The motion of the earth around the sun.
 - (v) The motion of a falling stone.
 - (vi) The motion of a swing.
17. Which of the following is *not* an example of the muscular force:
 - (a) A porter carrying a load on a wheel-barrow.
 - (b) An apple falling from a tree.
 - (c) A child riding a bicycle.
 - (d) A person drawing water from a well.
18. What are the different types of forces. Give an example of each.
19. Which of the following is *not* an example of force of gravity:
 - (a) A leaf falling from a tree.
 - (b) A person pushing a cart on a level plane.
 - (c) A diver jumping into a swimming pool.
 - (d) A stone falling from the top of a tower.
20. What is a machine? Name a few simple machines.
21. What is the Principle of work as applied to a machine? Do you think that in actual practice the efficiency of a machine is 100%? If not, explain why?
22. What is the relationship between force and distance as applied to a machine? Explain it with an example.
23.
 - (a) What is a lever?
 - (b) Define load, effort and fulcrum as applied to a lever. Draw a lever and mark their positions on it.
 - (c) Name the various classes of levers and give three examples of each class of lever.
24. Why are levers of the third type less common than those of the first and second types? To what class of lever do the following belong?
 A pair of scissors; a wheel barrow; a steelyard; an oar in a boat; a pair of pincers; pump handle; fishing rod; a crowbar.

25. Draw a pulley system. What is it used for ?
26. Explain (i) why is an inclined plane regarded as a machine ? (ii) Why do Nagas feel it difficult to climb up and climb down a hill ?
27. How does a screw help in opening corked bottles ?
28. How do wheels help in moving objects ?
29. What are Gears? Explain how gears are regarded as a machine ?
30. How can you shift a heavy stone on the field without using much force ?
31. Why is it easy to open the lid of the tin with the help of a spoon ?
32. Why is it easier to push the barrel on the tilted wooden plank ?
33. Why is the Ghat (or Hill) road built with a small angle ?
34. Why should we take proper care of machines ?
35. Match the statements in Column A with those in Column B.

Column A	Column B
1. Wheel	1. is a modified form of an inclined plane.
2. Pulley	2. is a rigid bar which can rotate about the fulcrum.
3. Lever	3. helps to lift an object by applying a force less than the weight of the object.
4. Inclined Plane	4. is a small wheel fixed on an axle about which it can rotate.
5. Screw	5. helps us to move objects with very little effort.

36. Why is the oiling of some parts of a machine necessary ?
37. Classify the following levers as the first, second and third type :
Beam balance; tweezers and lemon squeezer.
38. In the following statements write 'T' against those statements which are true and 'F' against those which are false :
(i) The point at which a lever is supported is called its fulcrum.

- (ii) A pair of tongs is an example of lever of the second type.
- (iii) It is easier to roll a heavy drum on an inclined plane than carrying it up directly.
- (iv) A sewing machine is an example of a simple machine.
- (v) A crowbar helps you shift a heavy load faster.
- (vi) A pulley fixed on a well helps in drawing more water with less effort.

39. Complete the following sentences:

- (i) In the lever of the first type is in the middle.
- (ii) The pulley changes the of force.
- (iii) The point of support in a lever is called its
- (iv) The outer parts of machines are painted to protect them from

40. Which of the following is *not* a function of machines ?

- (a) To make our work faster.
- (b) To make our work convenient.
- (c) To enable us make the measurements correctly.
- (d) To enable us lift more load with less force.

41. Define speed of a body. Mention its unit.

ACTIVITIES

1. Fix a rubber string a piece of an ordinary thread stretched between two nails on a hollow wooden box. Pluck it just like the string of a sitar (or a violin). Observe its motion. What type of motion is this ?
2. Take a piece of card-board. Hold it in between two fingers. Release it gently so that it falls down. Note the path along which the card-board falls. Hold the card-board again in between the fingers. Release it again so that it falls down. While it is falling, strike it with a finger of the other hand. Observe its motion now. Does it fall along the same path as before ? Why did the direction change ?
3. Take a feather. Rub it between the pages of a book by pulling it out of the book pressing it slightly. Rub it four or five times. Now hold the rubbed feather in one hand and bring one of your fingers near it. Observe the movement in the fibres of the feather and name the force which causes this movement ?
4. Take a piece of card-board and keep it inclined using a brick on a cemented floor. Take a ball and keep it on the card-board. Release the ball. Measure the distance the ball travels from the card-board on the cemented floor. Repeat this activity on a kachcha floor when the same force is applied. Measure the distance the ball travels again. The ball should be released from the same point on the card-board. On which floor did the ball travel a larger distance ?
5. Collect the various tools used in your environment and classify them into the types of lever they belong to.

CHAPTER VII

THE LIVING WORLD

You see living things all around you. All living things are the forms of matter like all the non-living things, as they all have weight and occupy space. Plants, animals and micro-organisms form the living world.

7.1 Characteristics of living things

It is now accepted that a thing is alive if it shows the characteristics listed below :

(i) Movement

Living things move in a directed and controlled way. They move of their own accord.

(ii) Sensitivity

Living things are sensitive to their surroundings. They detect and respond to

the changes in the world around them.

(iii) Feedings

All living things feed. Food is the material from which organisms obtain energy for movement, and the raw materials necessary for growth and repair of the body.

(iv) Respiration

Living things respire. Respiration involves series of chemical reactions which result in the release of energy. These reactions are *vital for life*.

(v) Excretion

All living things remove from the body the waste, produced from the normal life processes.

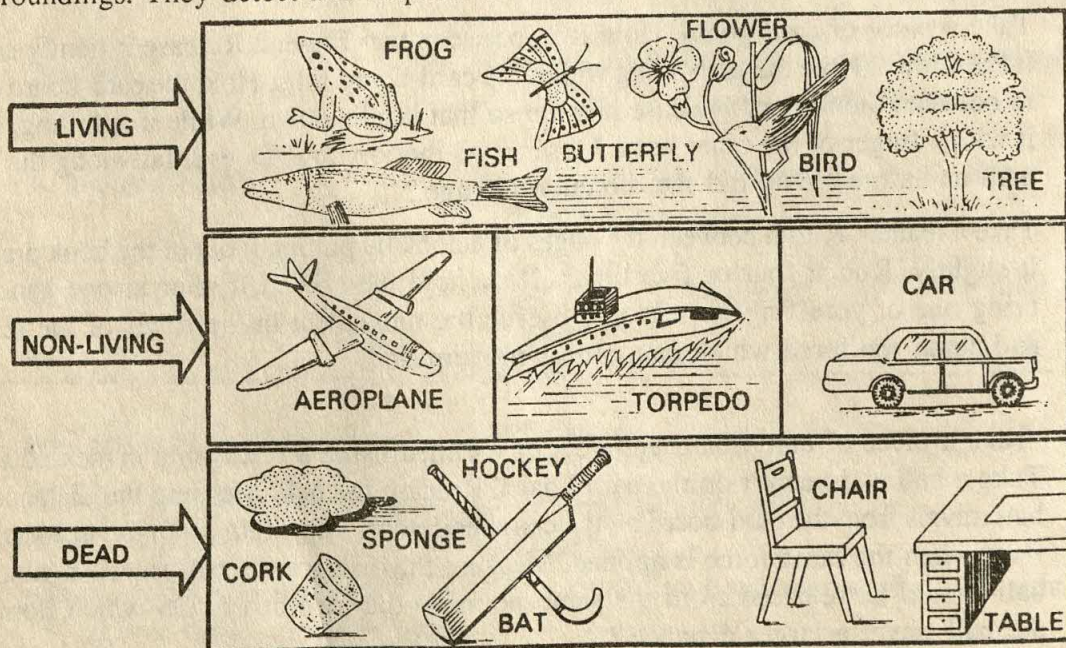


Fig. 7.1 Living, Non-living and Dead Objects

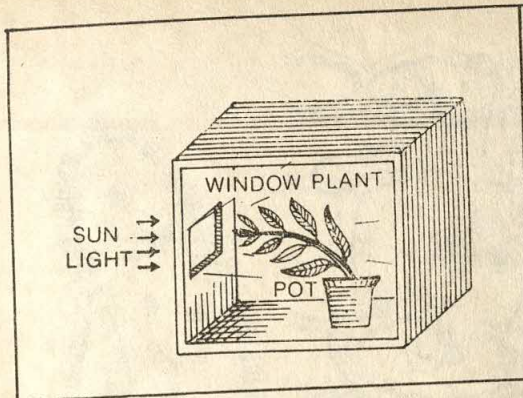


Fig. 7.2 Movement—
Plants bend towards light

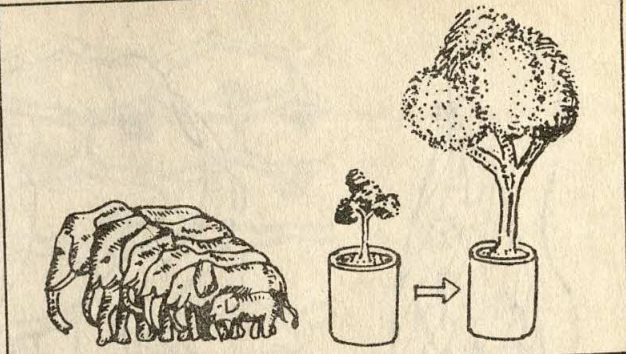


Fig. 7.3 Growth in animals and plants

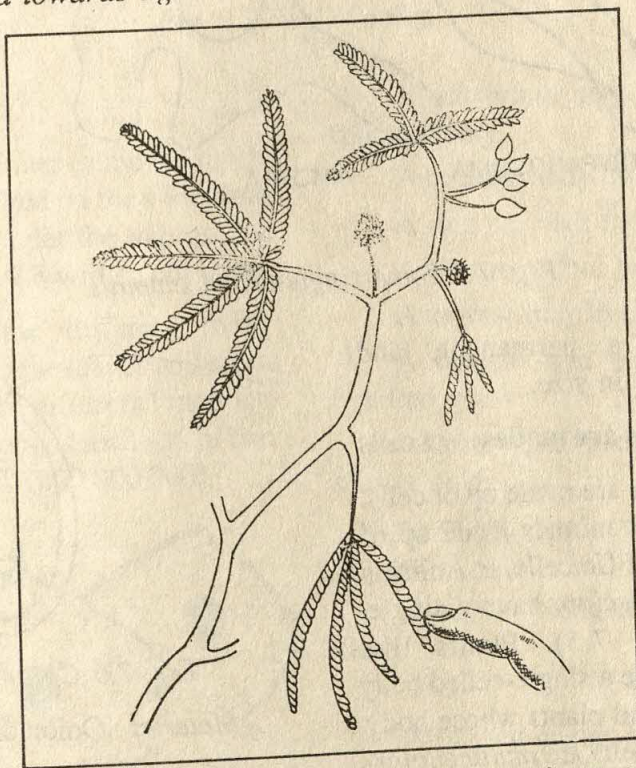


Fig. 7.4 Sensitivity—Leaf of Mimosa is sensitive to touch

(vi) Reproduction

No organism has a limitless life, but although individuals must die sooner or later, their life is passed on to the new individuals by *reproduction*. All living beings produce their own kind as a result

of reproduction.

(vii) Growth

All living things grow in size. Most animals grow until they reach maturity and are ready to reproduce. Plants usually *grow in size* all through their life. Growth in

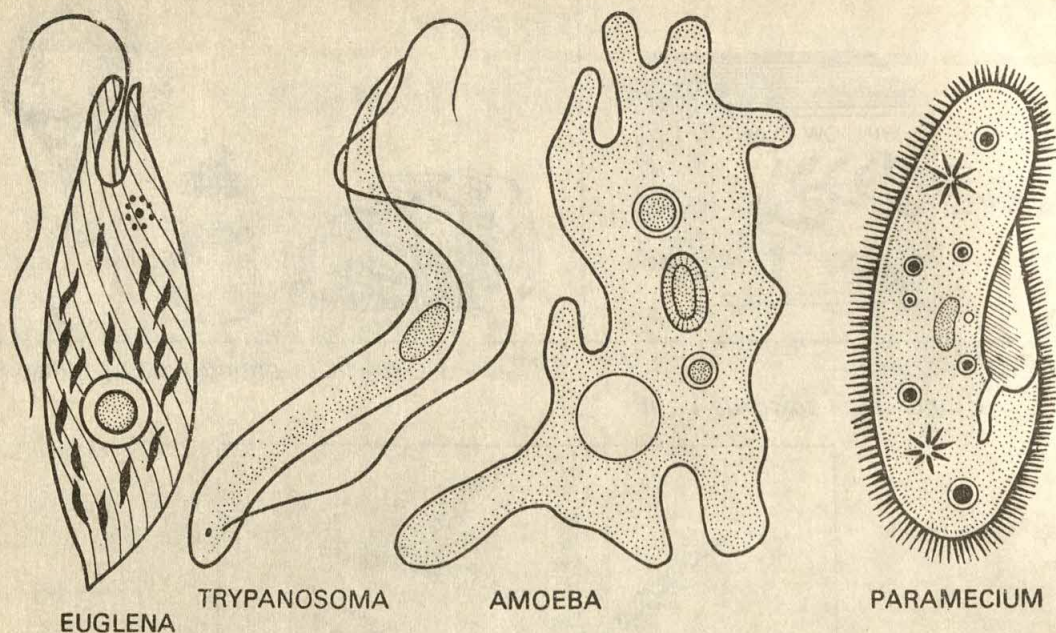


Fig. 7.5 Some single-celled animals

living beings is a permanent, and irreversible increase in size.

(viii) All living things are made up of cells

All living things are made up of cells. There are plants and animals made up of single cell only, called *Unicellular*. Animals like *amoeba*, *paramecium* have a single-celled body (Fig. 7.5). Plants like *Chlamydomonas* have a single-celled body (Fig. 7.6). Animals and plants whose body is made up of many cells are *multicellular*. Plants like mosses, ferns and flowering plants, animals like earthworm, insect, fish, human being etc., are some of the multicellular organisms.

Activity : To observe Plant cells

Things needed: A glass slide, a cover slip, a needle and a microscope.

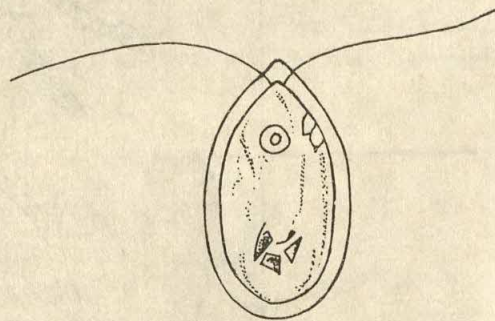


Fig. 7.6 *Chlamydomonas*

Material : Onion or any leaf of a plant.

Method: Peel off a thin scale from onion or any leaf of a plant.

Put it on the slide and observe under the microscope.

Rectangular cells with a nucleus can be observed (Fig. 7.7.)

Activity : To observe Animal cells

Things needed: A glass slide, a cover

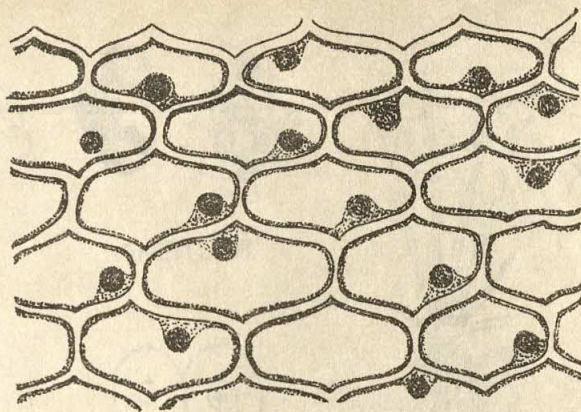


Fig. 7.7 Peel of onion

slip and a microscope.

Method: Run a finger round the inside of the cheek. Put the fluid on the slide from the finger. Examine under the microscope cells as shown in Fig. 7.8 will be observed.

The cells in the different living organisms are of different shapes and sizes. Different cells perform different functions. Do you know, your brain is made up of two hundred million cells (200,000,000).

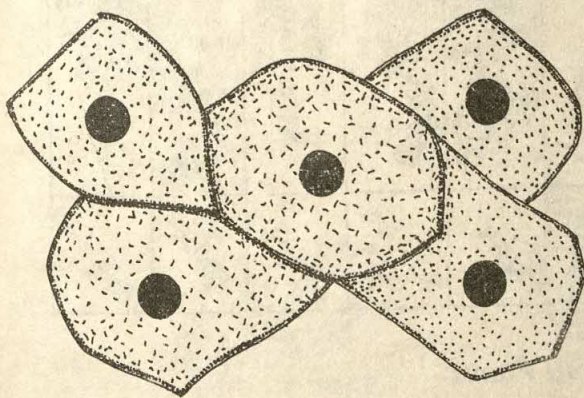


Fig. 7.8 Human cheek cells

(ix) Define Life Span

All living organisms live for a set period of time.

A *bacterium* may have a life of 20 minutes only.

A housefly may live for over a month.

A dog can live for 17—18 years.

A lion may live for 25 years.

A tortoise may live for 120-140 years.

A banyan tree may live for many hundred years.

A sweet pea plant may live for a season only.

A radish plant may live for two seasons.

A human being may live for 60-75 years.

All living beings have a definite start of their life from *their parent*. They grow and after completing their life, they all die.

7.2 The Variety of Living things

There are about 15,00,000 different organisms known to science and more are being discovered all the time. Have you

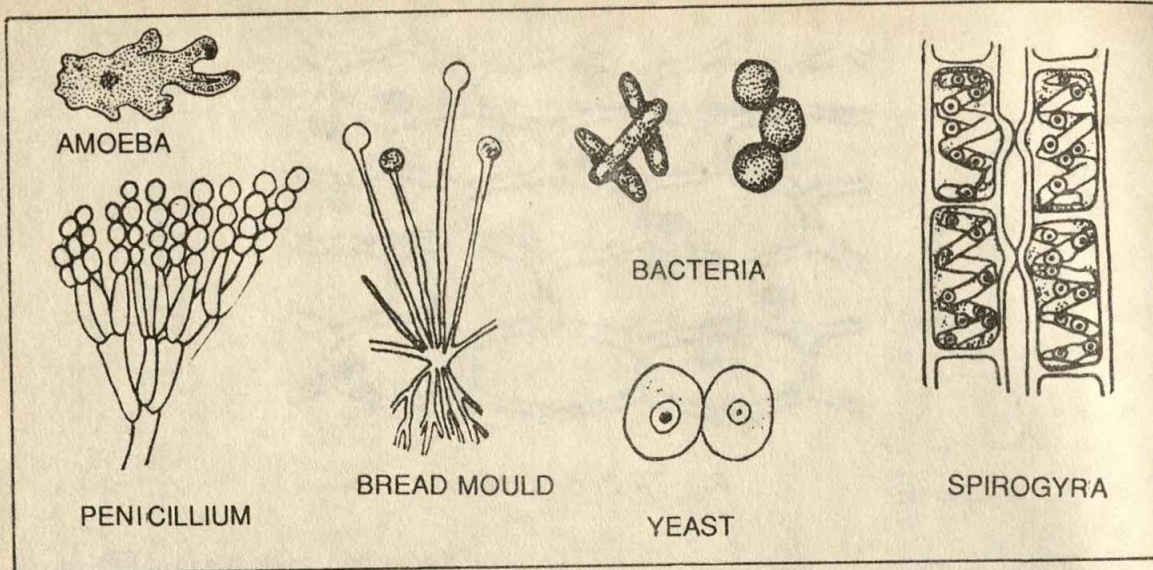


Fig. 7.9 Some Micro-organisms

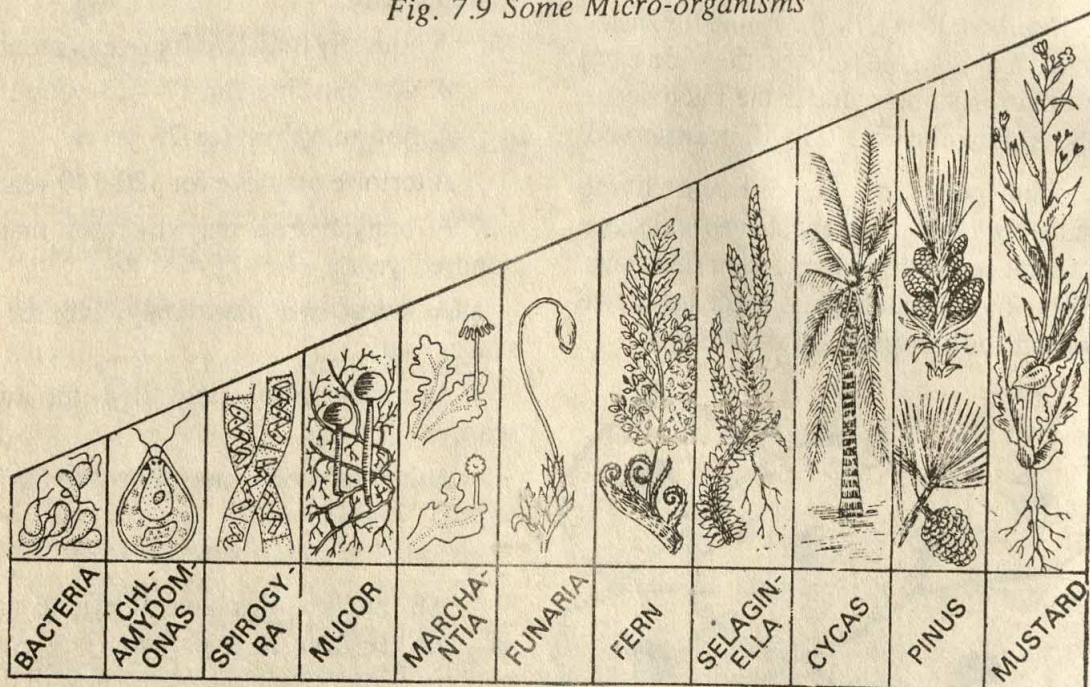


Fig. 7.10 Plants

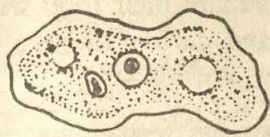
seen all the organisms present on the earth?

No, it is not possible to see all the organisms.

Whatever plants and animals you see

around you; don't you appreciate the tremendous variation in the living organisms?

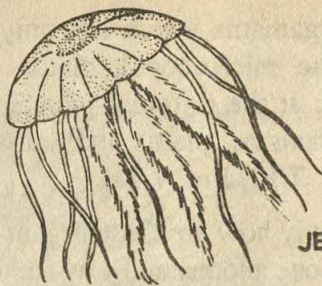
There is a vast variation in the micro-



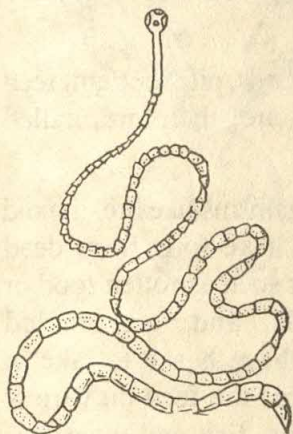
AMOEBA



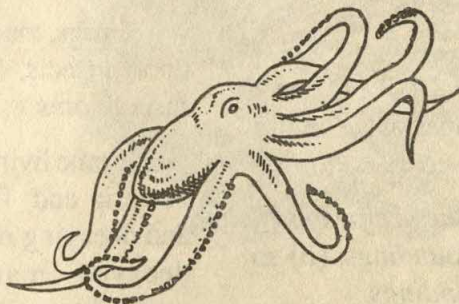
SYCON



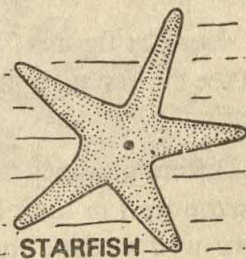
JELLYFISH



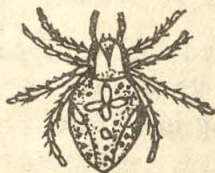
TAENIA



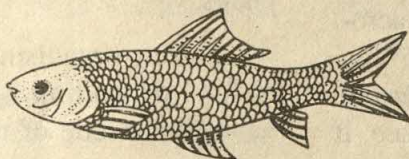
OCTOPUS
(DEVIL FISH)



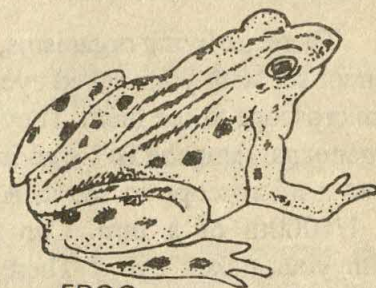
STARFISH



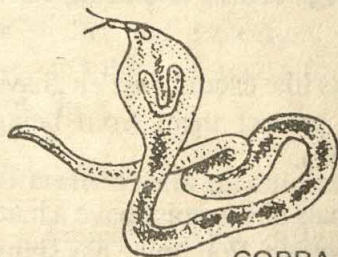
SPIDER



FISH



FROG



COBRA



KOEL



LION

Fig. 7.11 Some Animals

organisms (organisms which can only be seen under the microscope), plants and animals. Look at the different pictures of the micro-organisms, plants and animals. (Fig. 7.9, Fig. 7.10, Fig. 7.11).

Let us study how are these organisms different from one another and why are they different from each other ?

1. Variation in Shape

Look at figures 7.9, 7.10, 7.11, don't you see the variation in shapes of the living beings.

Different shapes *help the organisms* (i) *to settle well in their surroundings*, (ii) *to move well in their surroundings*.

2. Variation in Size

There are living organisms, which you cannot see with your naked eye. You need a microscope to see them. They are micro-organisms. Amoeba is 1 mm in size. You need a microscope to see it. A bacterium is 1/1000th of a mm. Can you see it with your naked eye ? There are many plants and animals which are small but you can clearly see them.

Some trees are many hundred metres tall.

Blue whale is the biggest animals on earth. It lives in sea. A single blue-whale may weigh few hundred tons.

Elephant is the largest land animal.

3. Variation in Food

All living beings do need food, but different organisms need different kinds of food.

Green plants prepare their food with the help of water and carbon dioxide in presence of sunlight.

Goats, sheep, cow etc., feed upon green plants. They are called *herbivores*. Lions, tigers, snakes etc. feed upon goat, sheep, deer, rabbits and other animals. They are called *carnivores*.

Frogs, toads, lizards, pitcher plant feed upon insects. They are, therefore, called *insectivores*.

Some living organisms like bread mold bacteria and fungi take food from dead and decaying matter such as rotten food or decayed materials and are called *saprophytes*. Birds have beaks to take in their food from. Birds too feed on variety of food—grain, fruits, fish and meat etc.

Bear can feed on flesh as well as plants.

Living organisms need different type of food depending upon its surrounding, habits and mode of taking in of food.

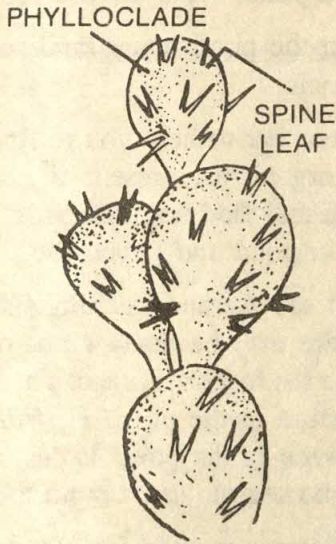
Variety of ways of Protection

Different organisms avoid being eaten by enemies.

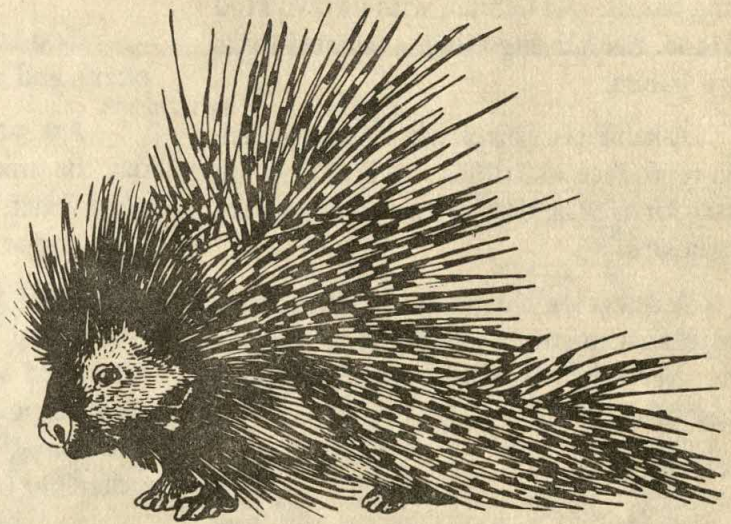
Some plants like cactus, rose etc., have *thorns*. Thorns protect them from being eaten (Fig. 7.12a).

Many animals like tortoise have a hard *armour* for protection. Porcupine has spiny thorns all over the body for protection (Fig. 7.12b).

Many animals depend upon *speedy escape* as means of protection. There are animals like rats, squirrels, ants, earthworms



(a) Plant with thorns



(b) Porcupine

Fig. 7.12

snakes make burrows in the soil and live in the holes as means of protection (Fig. 7.13.)

Honey bees make a beehive and live as shown in Fig. 7.13. Birds build different kinds of nests according to their needs and ability for shelter and protection (Fig. 7.13).

Human beings also live in their homes for shelter and protection. Many animals live in thick forests for shelter and protection.

Different habits of animals

Animals show different kinds of habits.

There are animals which are very active during the day, whereas some animals are active during the night.

Where do you find moths and

mosquitoes? These animals are very active near the lighted bulbs.

When do you find butterflies and birds in full activity?

These animals are active during the day. Bats, owls and snakes are active during the night.

Eagles rest in their nest at night, fireflies (Jugnu) are very active at night. The activity of the different animals show lot of variety.

7.3 Habitat

A special *environment* where an organism lives is called its *habitat*. A *natural home* is its *habitat*. Even if the environment of all fish is water, each fish has a special *habitat*. In that habitat it finds its special food. An eagle cannot live on grass. A cow

cannot live on mice. Each kind of living thing has its own habitat, with its own kind of food. Each living thing is adapted to its own habitat.

A habitat is a place where an organism can reproduce its babies safely. There are *many kinds of habitat* on the earth for living organisms.

A desert is a habitat. A sea, a sea shore, the river, a stream, a grass land, and ocean etc., are different habitats for different organisms.

Activity 1 :

A visit to a zoo. Observe different animals. Different animals are put in the zoo, almost like in their natural habitat.

Activity 2 :

A visit to a pond. What do you see?

You see in the pond many kinds of plants and animals.

Ask your teacher to help you to find out the micro-organisms, present in the pond water. You may find frog, fish, frog's eggs, tadpoles in pond and larvae too.

You might see a crane catching fish from pond. There may be many kinds of insects on which the frogs may feed. There may be pond scum in the pond. *Hydrilla* plants may be seen in the pond. Lotus or water lily may be seen in same pond too.

A pond habitat is specific for specific animals and plants. Different organisms in a habitat have different food habits (Fig. 7.14).

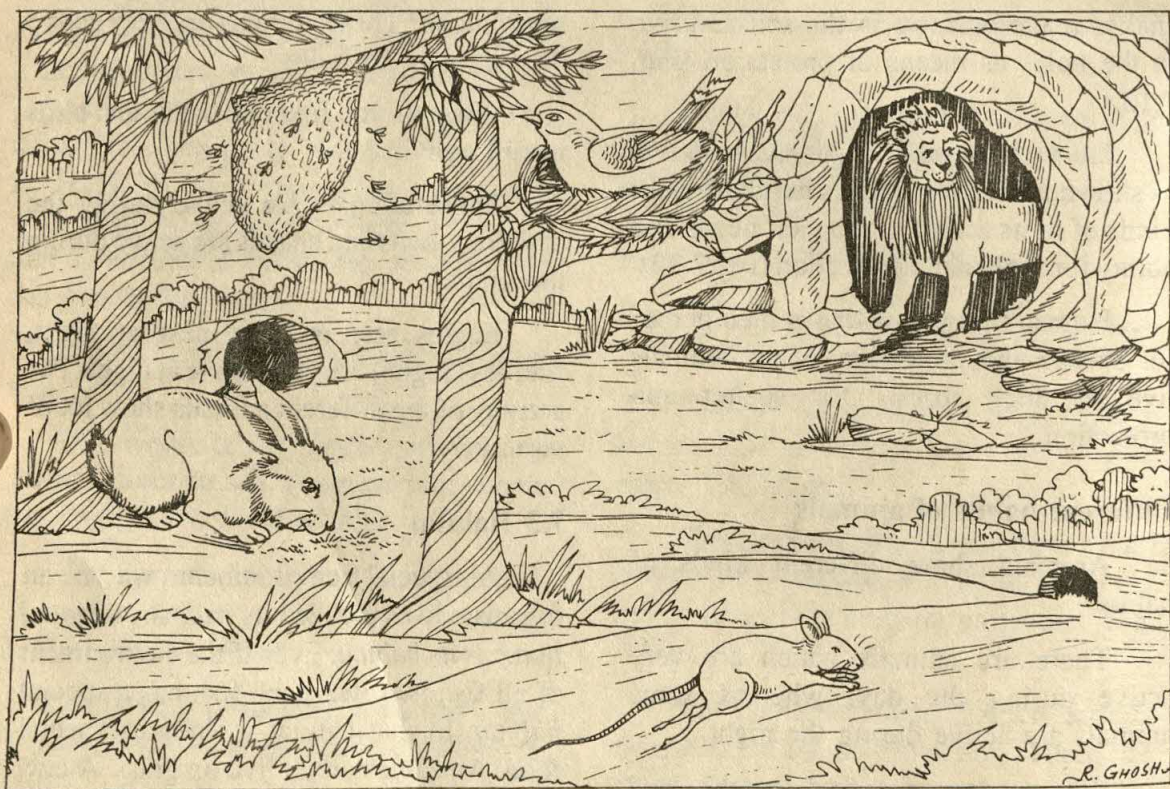


Fig. 7.13 Shelter of some animals

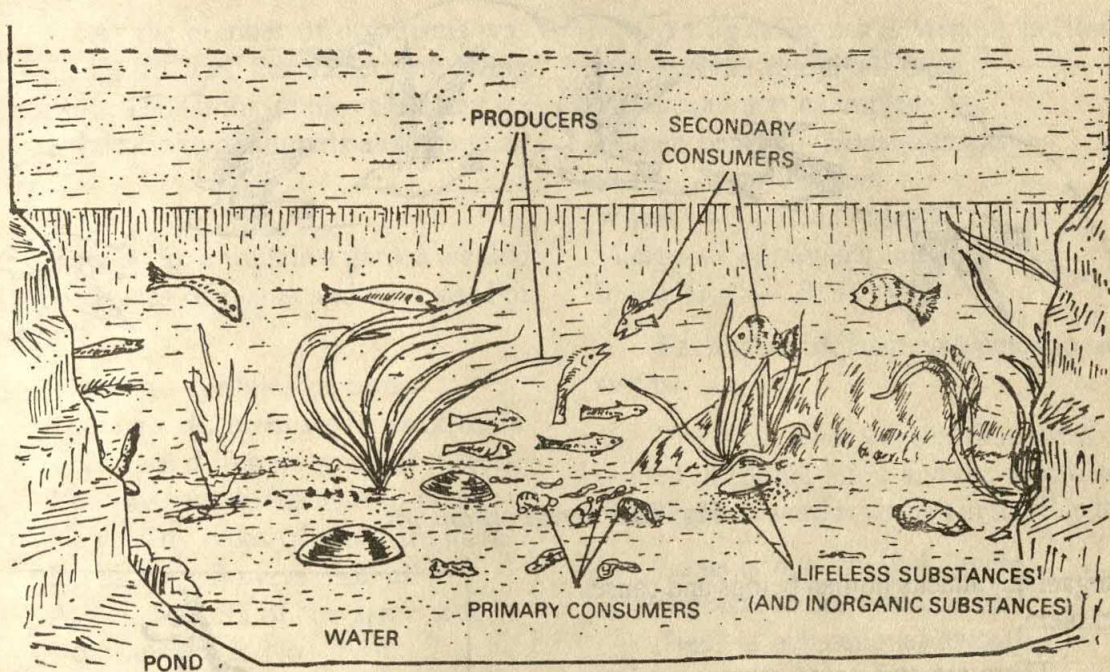


Fig. 7.14 Life in a pond

Types of Natural Habitats

1. Aquatic organisms living in water. Aquatic organisms living in sea water are called Marine, for example whales, sharks, star fish etc., some types of marine algae.

Aquatic organisms living in ponds, ditches, and rivers are called *fresh water organisms* like hydra, green scum, tadpoles, some types of fish.

2. Terrestrial. These are organisms living on land, like snakes, lizards, rats, mice, wheat plant, rose plant and many other organisms. You see them all around you.

3. Amphibians. These organisms live

partly in water and partly on land like frog, mosses etc.

4. Aerial. Organisms living in air, like birds and small micro-organisms are called Aerial organisms (Fig. 7.15).

5. Parasites. These are organisms living on other living organisms and causing harm. Organisms on which parasites live are called *hosts*.

Organisms living on the hosts and causing harm are called *parasites*.

Malarial parasites live on us and cause malaria.

Amarbel seen on Kadam trees and kills the latter.

A comma-shaped bacteria (Micro-

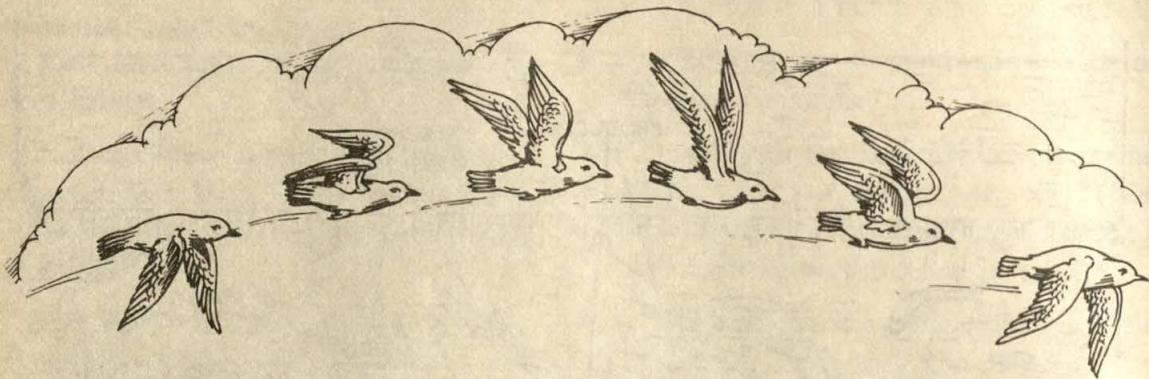


Fig. 7.15 Aerial organisms

organism) attacks human beings and causes cholera.

There are still some other organisms having very specific habitats with respect to the climatic conditions:

1. Walrus and Reindeer—Polar regions.
2. Camels—Deserts.
3. Marsupials (Kangaroo)—Australia (Fig. 7.16).
4. Eucalyptus—Australia.
5. Kiwi—New Zealand.
6. Ostrich—Africa.
7. Giraffe—Africa.

There are organisms living at the same place all through the year, others migrate from their home during some seasons to a place thousands of kilometres away. Such organisms are *migratory*. Commonly birds migrate in winter season from mountains to plains. Migratory birds are seen in winters in Bharatpur sanctuary near Delhi. The birds in these sanctuaries come from various parts following different routes.

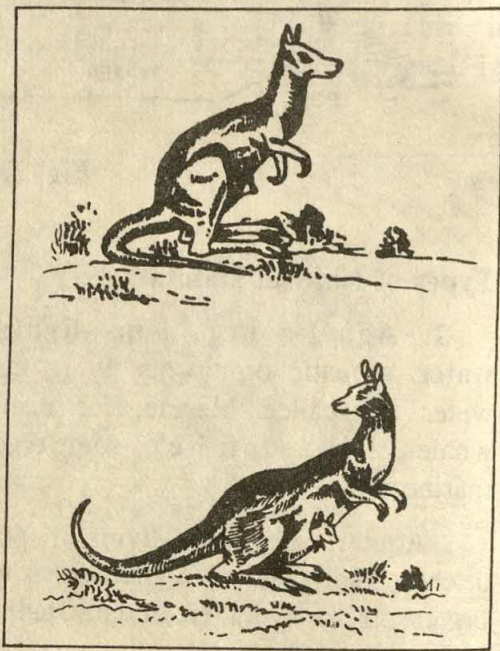


Fig. 7.16 The kangaroos

People study their routes by a process of banding. This process involves just tying an aluminium band with day, date, year and place written. We have seen that habitats of living organism vary a lot.

7.4 Species

As the number of organisms was increasing, so was the variety of living organisms. Thus from simple cells today we have a vast range of animals and plants all over.

If we go for a walk in a garden we find different types of plants and animals. For example :

There are varieties of birds.

There are different varieties of roses.

There are different types of insects.

You observe different rose plants.

How many types of roses are there ?

Do all rose flowers look alike ?

Are all flowers of the same size ?

Your answer is No.

But still, we call them roses as there are large number of similarities.

So we say, these rose plants are representing a single kind --- such kinds of the same group are called *Species*. Similarly we see in all other organisms. Each group of organism has number of species like in the cats, dogs, cows, horses, wheat, rice, sugar-cane, etc.

Species have the ability to mate together and produce young similar to themselves.

The characteristic of a species is the ability of its members to mate and produce fertile off springs (young ones).

For convenience and easy communication with people all over the world — All Living Organisms have been given standard names called *Scientific names*. These are same all over the world and can never be changed. These names are

written in Latin. For example :

A frog in English is Menduk in Hindi, but, is *Rana tigrina* all over.

Some common examples :

Human being — *Homo sapiens*

Pea — *Pisum sativum*

Wheat — *Triticum vulgare*

Mango — *Mangifera indica*

Indian frog — *Rana tigrina*

Each scientific name is written in two words.

The first letter of the first word is written in capital letter and the first letter of the second word is written in small letter.

Lotus is our national flower.

Peacock is our national bird.

Tiger is our national animal.

The living organisms not only show variations in food, habits, habitat, shape and sizes, they have different ways of movements. They breathe in different ways. Even the different living organisms reproduce in different ways.

There is a lot of variation seen in different living organisms.

7.5 Classification of Living Things

There is lot of variation seen in the living things. Let us study, how are the living beings grouped. How do we group living being as a *plant* or an *animal* ? See the table on the next page.

Plants and animals have very *different body parts*, which makes it very easy to group them into two *definite groups*.

Have you noticed amongst animals and plants there is lot of variation seen?

Whenever a study of any animal or

<i>Plant</i>	<i>Animal</i>
Only single-celled plants show some movement. Plants other-wise are fixed. Chlamydomonas a single-celled plant can move. All green plants synthesis food in presence of light carbon-dioxide and water. The process is called <i>photo-synthesis</i> (photo means light <i>i.e.</i>, synthesis of food in presence of light. Plants reproduce in many ways : (i) By seeds (ii) By spores (iii) By some parts of the plant. In Bryophyllum, leaf gives rise to a new plant. In ginger, in potato- a little part when put in the soil gives rise to a new plant. (Fig 7.17).	Mostly animal show <i>movement</i>. They move in search of food. Mostly animals depend on plants and animals for food. Animals cannot prepare their own food. Animals reproduce by many ways. Some lay eggs—eggs hatch young ones come out like in hen, birds, lizards, frog etc. Animals like rat, rabbit, dog, cat, lion and human being give birth to young ones.

plant is to be made, you must observe its *characteristics*.

The characteristics include appearance, organs, living habits, habitat which make one living thing like or unlike another living things.

Using characteristics to divide things into group is called *Classification*. A characteristic, or group of characteristics is used to classify larger groups into smaller groups. In classification, the smaller group, the more characteristics are resembled by the member of that group. All plants are classified into a main group *Plant Kingdom*.

All animals are classified into a main group *Animal Kingdom*. Classification

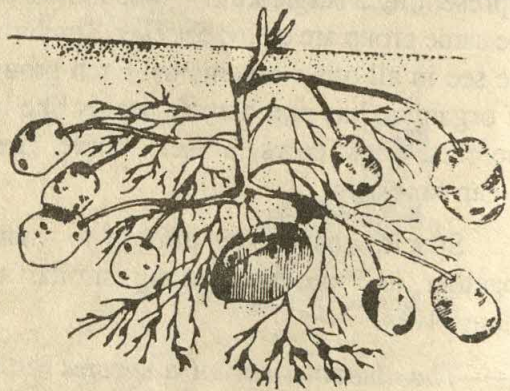


Fig. 7.17 Reproduction in Potato
makes the study of animals and plants easier and simpler.

Plant Kingdom

The main plant kingdom is classified on the basis of some important



Fig. 7.18 The Flowering Plants

characteristics. The plants which do not flower are *Non-flowering plants*, e.g., Bacteria, chlamydomonas, moss, fern, pine, Fig. 7-10.

If you see the damp walls, you will see mosses, on the hills stations pines are common. Ferns are very common as garden ferns. Some non-flowering plants like chlamydomonas, bread mold and mosses do not have roots, stem and leaves.

Ferns, and pines have roots, stem and leaves well developed.

The plants which flower are called *flowering plants*, e.g., pea plant, sunflower plant, rose bush, mango tree (Fig. 7-18).

Flowering plants have well developed roots, stem and leaves. Flowering plants may be very tall *trees*. Trees have branched woody trunk. Flowering plants may be woody, but small in height as compared to trees. In such cases, branches come out from a point as in Rose bush. Such plants are *Shrubs*.

There are some flowering plants, having green delicate stem, small in size as pea plant. These are *herbs*.

Do you know banana is also a herb. It does not have a woody stem Fig. 7.18. Palm is also a tree, but does not have branches (Fig. 7-18).

Flowering plants can be classified on

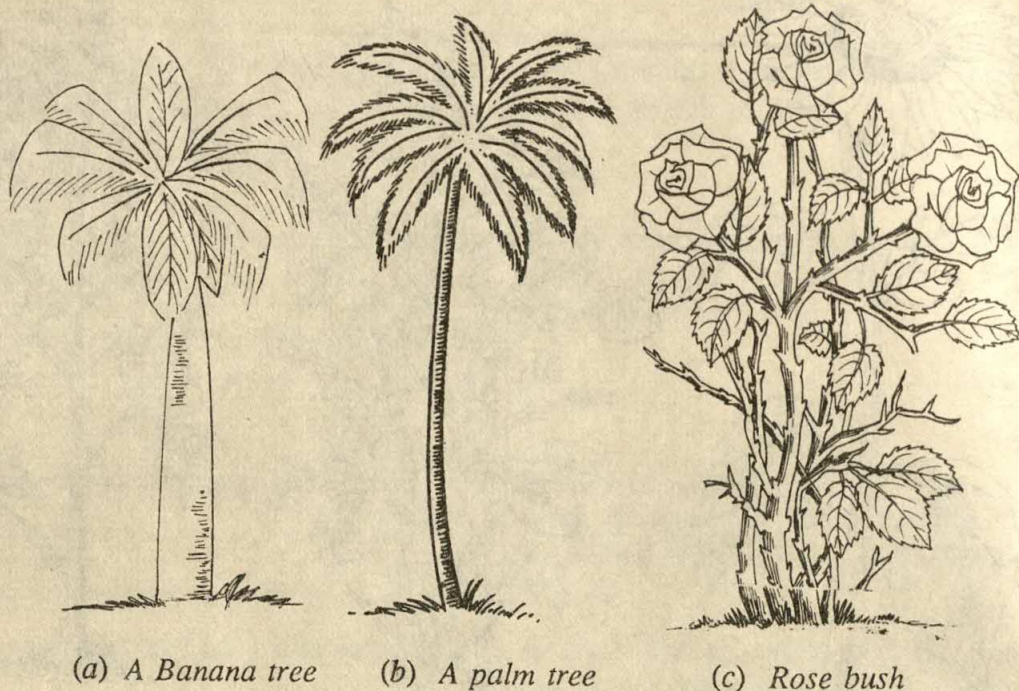


Fig. 7.19

the basis of their life span.

Plants which complete their life in one season are *annuals* like mustard, pea, pansy, petunia etc. Plants which complete their life in two seasons are *biennials*, like carrot, radish, etc.

Plants which take more than two seasons to complete their life, or the plants which live for many many years are *perennials*—like mango tree, jamun tree, neem tree, etc.

Animal Kingdom

Animals are generally classified on the basis of backbone. Backbone is called *Vertebral column*. Vertebral column is made up of small bones called *Vertebrae*.

Animals having no vertebral column

are *Invertebrates*.

Animals having backbone are called *Vertebrates*.

Invertebrates

There are many kinds of invertebrates—amoeba, hydra, earthworm, insects, and snails etc., (Fig. 7.5 and 7.9).

Vertebrates

There are many kinds of vertebrates fish, frog, lizard, snake, bird, squirrel, bear, whale and man (Fig. 7.20).

Vertebrates like *fish* and *lizards* have their body covered with *scales*.

Lizards have dry scales.

Fish has soft scales.

Body of frog is *slippery* to touch.

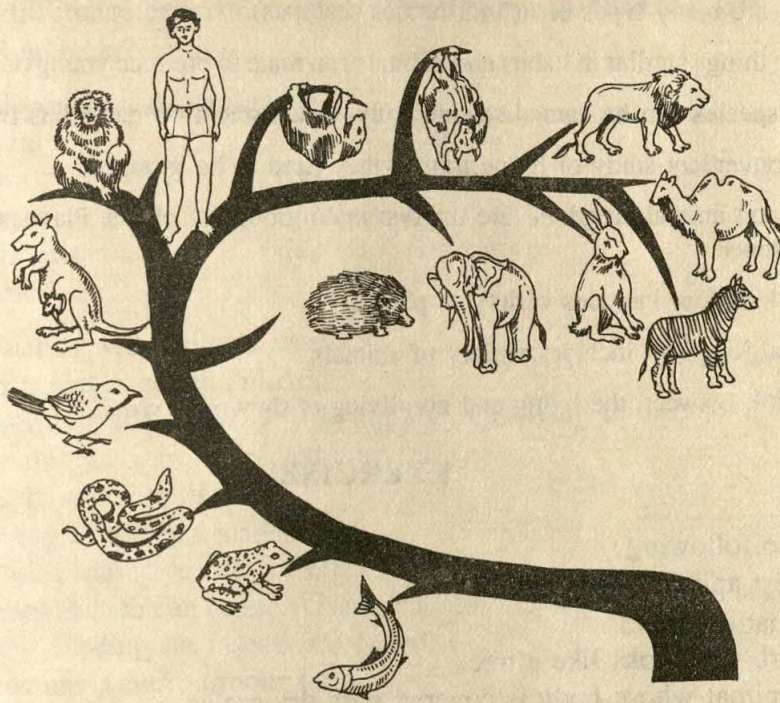


Fig. 7.20 Vertebrates

Body of birds is protected by *feathers*.

Body of rat, dog, rabbit, human beings is covered with hair.

All animals which have their body covered with hair give birth to *young ones*.

If you still observe the plants and animals closely, you will see more variations and characteristics.

It is very interesting to observe the *living world*.

The link between living and non-living is shown by *Virus*. It is living in a living body, and is dead like a crystal outside a living body. *Virus* cause many diseases in human beings, animals and plants.

SUMMARY

1. All living beings have some common characteristics like movement, sensitivity, feeding, respiration, excretion, reproduction, growth, body made up of cells, definite life span.
2. There is variation in living things—micro-organisms, plants and animals.
3. Living things show variation in size, shape, food, ways of protection, habits, habitat (natural homes).

4. There are many types of natural homes (habitats).
5. Living things similar in habits and habitats can mate to produce young ones form a species.
6. Each species can be named scientifically—each scientific name has two words.
7. For convenient study of living things, they need to be grouped.
8. Plant and animal kingdoms are the two main groups of plants. Plants and animals show specific difference.
9. Plant kingdom includes variety of plants.
10. Animal kingdom includes variety of animals.
11. The link between the living and non-living is shown by *virus*.

EXERCISES

1. Name the following :
 - (i) Largest animal in the world.
 - (ii) Our national bird.
 - (iii) A herb that looks like a tree.
 - (iv) An animal whose body is covered with dry scales.
 - (v) A plant that lives in water.
 - (vi) Animal that lives in sea.
 - (vii) A single-celled plant.
 - (viii) A single-celled animal.
 - (ix) Animal that makes home in the ground.
 - (x) A plant that feeds on dead and decayed matter.
 - (xi) Animal that feeds on insects.
2. Give the scientific names of
 - (i) Human being
 - (ii) Mango
 - (iii) Pea plant
3. Give three differences between *plants* and *animals*.
4. What is the classification of animals based on?
5. What are :
Trees.....
Herbs.....
Shrubs.....
6. What is a habitat ?
7. What is a species ?

8. What is the difference between the growth of a baby into man and growth of a small rock into a big rock ?

9. Where would you find the following :

- | | |
|----------------|-----------------|
| (i) Whale | (ii) Pine |
| (iii) Moss | (iv) Lotus |
| (v) Frog | (vi) Polar Bear |
| (vii) Penguins | (viii) Kangaroo |
| (ix) Camel | |

10. Fill in the blanks with suitable words :

- (i) is a single-celled animal.
- (ii) forms a link between a living and non-living things.
- (iii) Living things.....in a directed way.
- (iv) is vital for life.
- (v) All living things are made up of.....
- (vi) A tortoise may live for.....years.
- (vii) Organisms which can be seen clearly with the help of a microscope are called.....
- (viii) Animals feeding on insects are called.....
- (ix) Tortoise has a hard armour for.....
- (x) Owl is active at.....whereas butterfly is active during the.....

11. How do the following help the animals ?

- (i) Shape
- (ii) Habitat

12. How do the following reproduced ?

- (i) Hairy animals
- (ii) Ginger and Potato
- (iii) Birds.

ACTIVITIES

- 1. Look for a aquatic habitat in your locality and name the animals and plants you observe in that habitat.
- 2. In your scrap-book paste some pictures of :
Trees Annual plants Biennial plants Vertebrates Invertebrates
- 3. If possible collect the nests of birds, and bring them to your class. (Make sure you do not touch a nest where there are eggs or young birds).
- 4. Visit a local zoo and see the different habitats of different animals.

STRUCTURE AND FUNCTIONS OF THE LIVING BODY

8.1 Structure and functions —Animals and plants

If you observe Fig. 7.9., 7.10 and 7.11 in the last chapter, what do you see?

Don't you agree that all animals and plants have some specific structures? These structures are common in some and are of special form in some others.

If you think about their body structures —each part of the body has a special function to perform. Make a list of animals and plants you see on your way to school from home and indicate the functions each part of their body performs.

Let us find out :

8.2 Plants parts :

There are many varieties of plants present.

There are very simple plants like algae (Unicellular *i.e.*, single-celled) Fig. 8.1.

There are complex plants with complicated structures like Mosses, Ferns, Palms and big trees etc. (Multicellular *i.e.*, many-celled).

Here we shall talk about the multicellular complex plants. We shall discuss in detail parts of a flowering plant.

We have studied in the last chapter that amongst these plants we find some plants attain a very small height, have delicate shoots and are green called herbs *e.g.*,

petunia plant, pea plant, and your common flowering plants in the garden. You know banana plant is also a herb.

There are some plants which attain some height and their stem is woody but not very tall sturdy. The branches come out from the common point, such plants are shrubs, for example, your rose plants. There are plants which attain very big height and are strong and woody called tree like mango trees, neem tree, etc. (Fig. 8.2).

You have seen that all plants have different sizes. Similarly if you see the different parts of the plants, you will find that in some :

- (a) The well-developed root system, or partly developed roots.

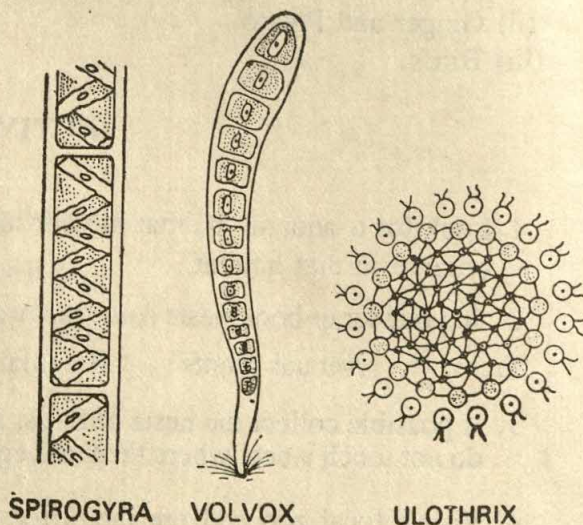


Fig. 8.1. Algae

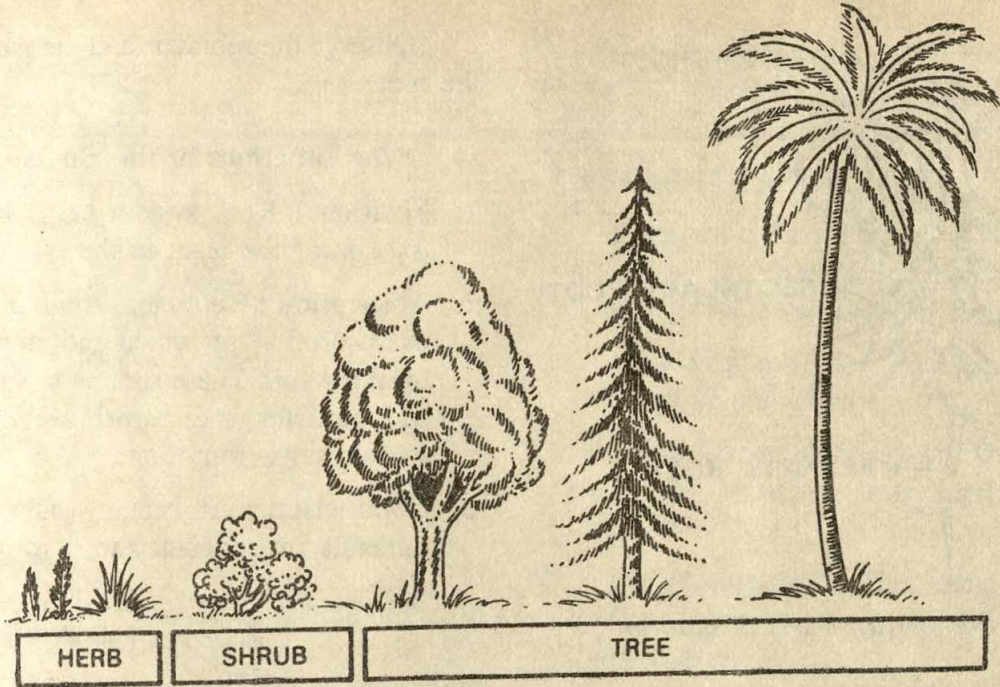


Fig. 8.2 Herbs, shrubs and trees

- (b) The stem is long and thin; in some, it is strong and tall, in some other, it is stouter etc.
- (c) The leaves are very long and strip like; in some, very big fan like (in Palms); in some, plants small.
- (d) The flowers are of different shapes, sizes and colours.

Therefore, we see there is lot of variation. Let us study each part of the plant individually.

8.3 Roots

(a) The Origin of the Roots

When a seed first begins to grow, two parts push out of the seed coat. The young shoot grows upward and soon it unfolds its first leaf. The first or primary root lengthens

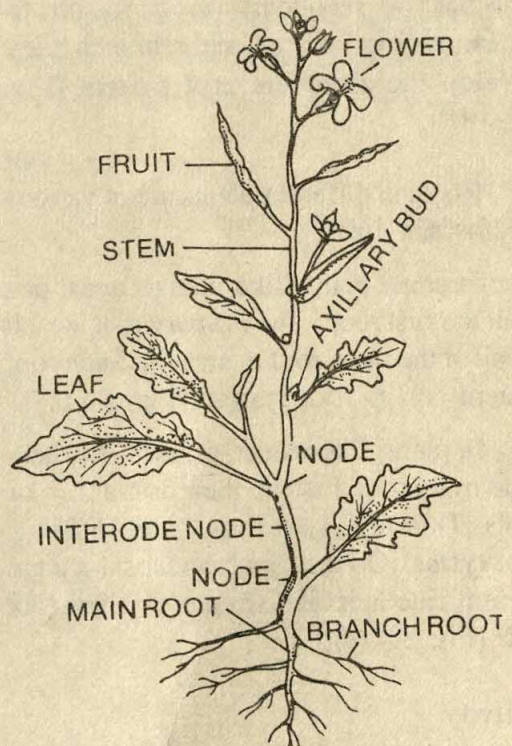


Fig. 8.3 Parts of a flowering plant

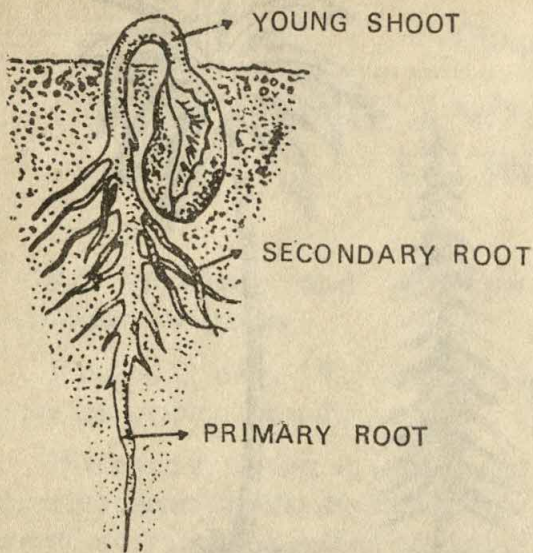


Fig. 8.4(a). Parts of the root

rapidly and quickly pushes its way down into the soil. After a short period of growth, branches or secondary roots, begin to appear. As roots branch and rebranch, they develop the complete root system [Fig. 8.4. (a)].

Roots in different plants are of various lengths and sizes.

In some plants like mango trees, pea plant the first root, the *Primary root*, which is called the main root is present. Such root system is *Tap root system* [Fig. 8.4 (b)].

In plants like wheat, grasses etc., there is no main root. Instead there is a bunch of roots. This root system is called *Fibrous root system*. On the root branches there are present fine hair like structure called *root hair* [Fig. 8.4 (c)].

Activity

Uproot a small plant and study the root system. Let it be a bunch of grass.

Observe the root hair and the parts of the root.

(b) Functions of the Roots

1. **Fixation** : Root system helps in the fixation of the plant in the soil.
2. **Absorption** : Root hair are important in absorption of water and minerals from the soil. These root hair stick to soil particles and absorb water and soluble salts from them.
3. **Conduction** : Absorbed water and minerals are conducted to stem by the roots.

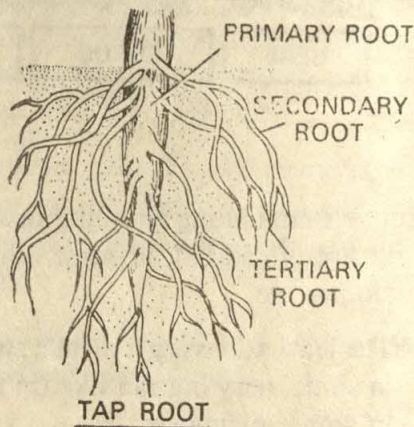


Fig. 8.4(b).

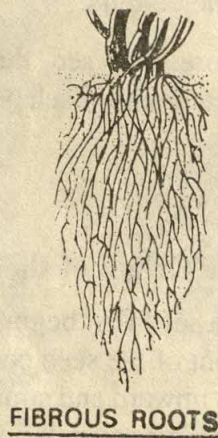


Fig. 8.4 (c)

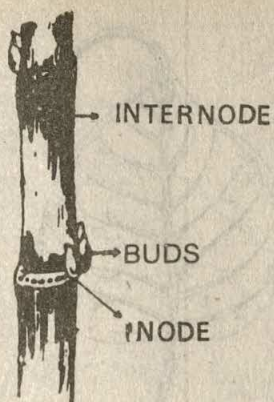


Fig. 8.5 Stem

8.4. Stem

Stem is the direct elongation of the first young shoot developing from the seed. It grows above the ground. It bears leaves, branches, flowers.

It is green when young and becomes stouter and woody when old.

The place on the stem or branch where one or more leaves arise is known as the *node*, and the space between two nodes is called the *internode*. On the nodes develop

small leafy structures called *buds*. These buds give rise to branches or flowers (Fig. 8.5).

Functions of the stem

1. A stem is an important link between roots and leaves and helps in conducting the material from roots to the leaves.
2. In woody plants, stem give support to the whole plant body.
3. *Bearing Leaves and Flowers*: The stem and the branches bear leaves and flowers.
4. *Food Manufacture*: The young stem, when green in colour, manufacture food material.

8.5 Leaf

Leaf is a flattened, outgrowth of the stem, or the branch developed from a node. It is green in colour (Fig. 8.6).

Parts of a leaf :

When the blade of the leaf, even

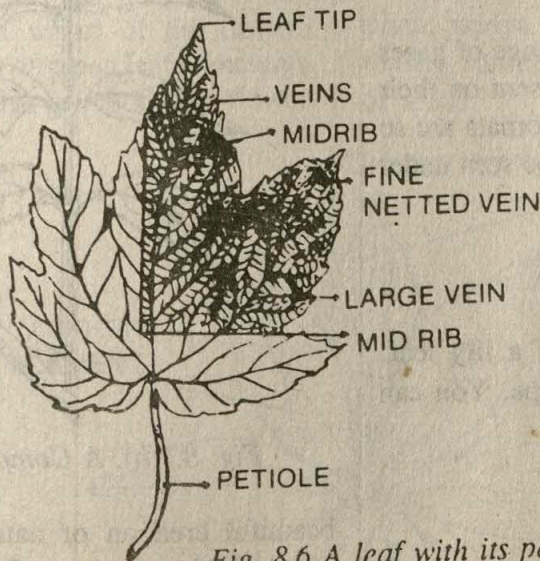


Fig. 8.6 A leaf with its parts

though greatly cut, is in one piece, it is called a *simple leaf*. [Fig. 8.7 (a)]

There are many leaves, however, where the blade is divided into three or more parts. In such cases the divided part of the blade looks like a leaf—and this leaf like structure is called a leaflet. Such leaves with leaflets are called *compound leaf* [Fig. 8.7 (b)].

Leaflets do not have buds in their axil.

Functions of the leaf

1. Leaf is considered as a food factory :

Leaf helps in the synthesis of sugar and starches for the whole plant body. This synthesis only goes on during the day time or in presence of light, therefore the process by which this synthesis takes place is called *photosynthesis* (photo+synthesis; photo means light). The chlorophyll (green pigment) present in the leaves helps in their photosynthesis to take place, with the help of water and CO_2 .

2. Leaves help in the exchange of gases from the small holes present on their surface called stomata (stomata are so small that they can only be seen under the microscope).

Activity

Peel the upper layer of a lily leaf. Observe under the microscope. You can see stomata.

8.6 Flower

Flowers are amongst the most



Fig. 8.7(a) A simple leaf



Fig. 8.7(b). A Compound leaf

beautiful creation of nature. But to the plants producing them, flowers are more

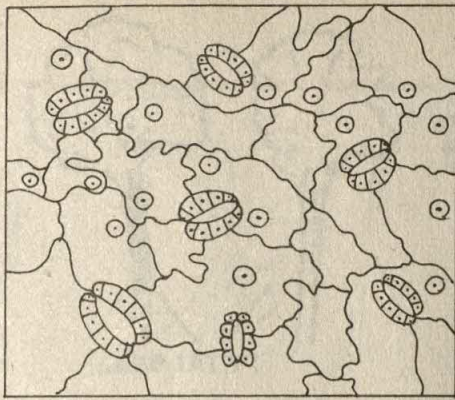


Fig. 8.8 Peel of leaf showing stomata

than beautiful creations. A flower is a specialized organ which reproduces the species. It exists only for a short time and then parts of it develop into the fruit containing the seeds which, in turn, produce a new generation of plants.

The Structure of a Flower Activity

Bring some flowers to the class and study the parts of the flower one by one. See Fig. 8.8 and 8.9.

Calyx

It is the first whorl of the flower, consists of number of green leafy structures called *sepals*. Calyx protects the flower

when it is in a bud form.

Corolla

It is the second whorl of the flower, and consists of number of brightly coloured leaf like structures called *petals*.

These petals attract insects.

Stamens

It is the third whorl of the flower and produces pollen grains. These pollen grains carry the male cells. A stamen has filaments and anthers. Anthers produce pollen.

Carpels

It is the fourth whorl of the flower consisting of ovary style and stigma. In the ovary the female cells are produced, which are present in the ovules.

The male and female cells of the flowers help in reproduction of the plant.

The ovary develops into the fruit. The ovules in the ovary develop into seeds.

The fruits are of different shapes, sizes and colours. For example, mango, litchi, plum, papaya, ladyfinger, chillies, brinjal, tomato, banana, etc. Fruits help in protection of seeds.

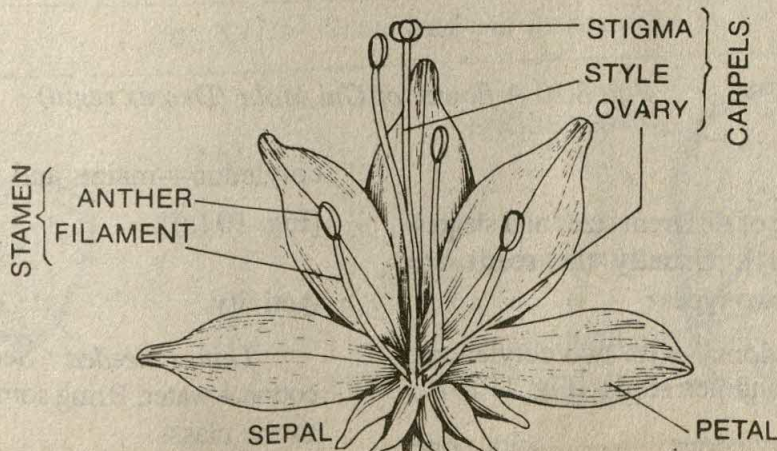


Fig. 8.9. Parts of Flower

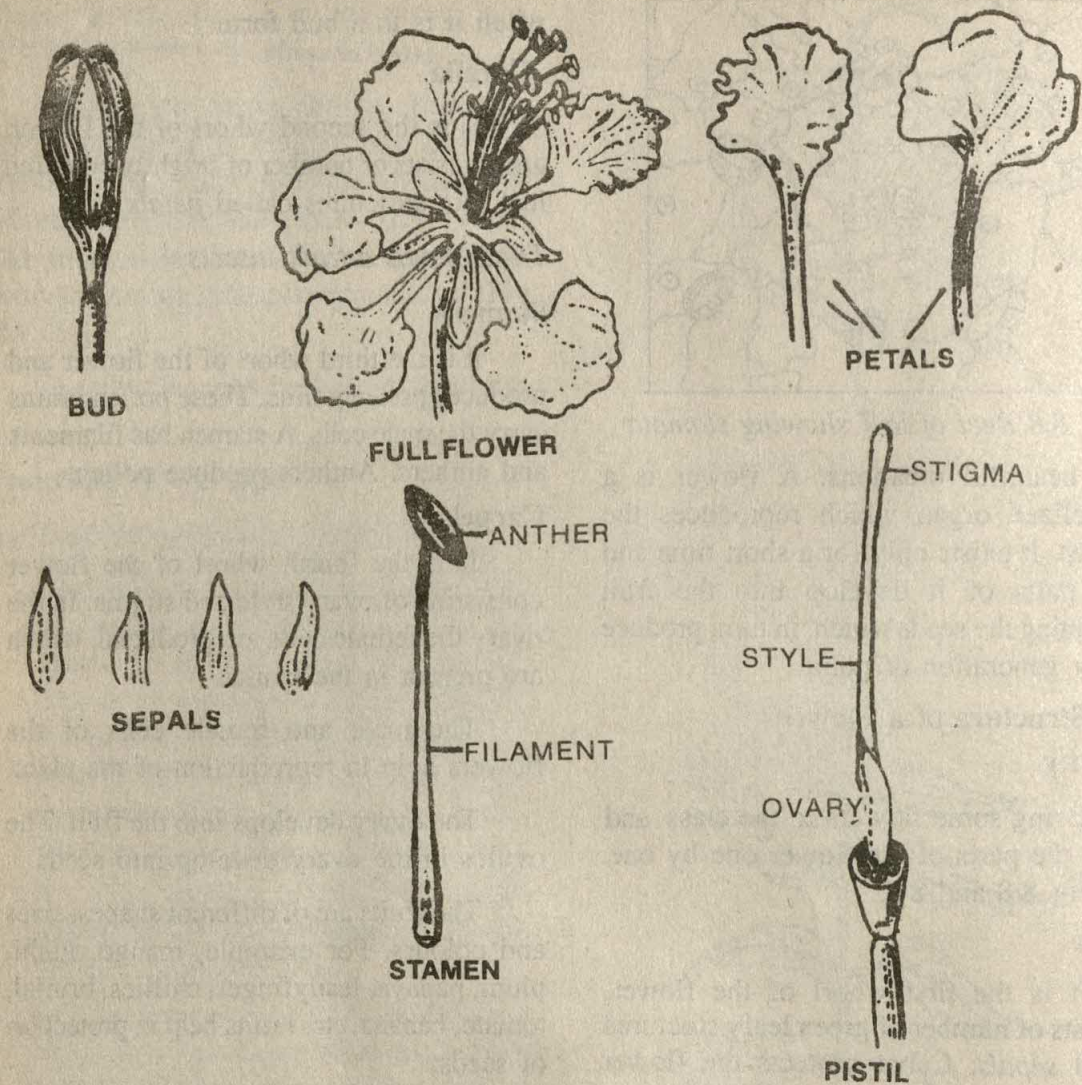


Fig. 8.10 A flower of Gul Mohr (*Deonix regia*)

Seeds

Seeds are of different sizes and shapes [Fig. 8.11 (a)]. Usually the seeds are grouped into two types :

- (a) Dicotyledons—with two cotyledons
—grain and pea seeds. [Fig. 11 (b)].
- (b) Monocotyledons — with one

cotyledon—maize and rice grains.
[Fig. 10 (c)].

Activity

Things needed : Seeds, saucer, cotton + water. Bring some gram seeds to the class.

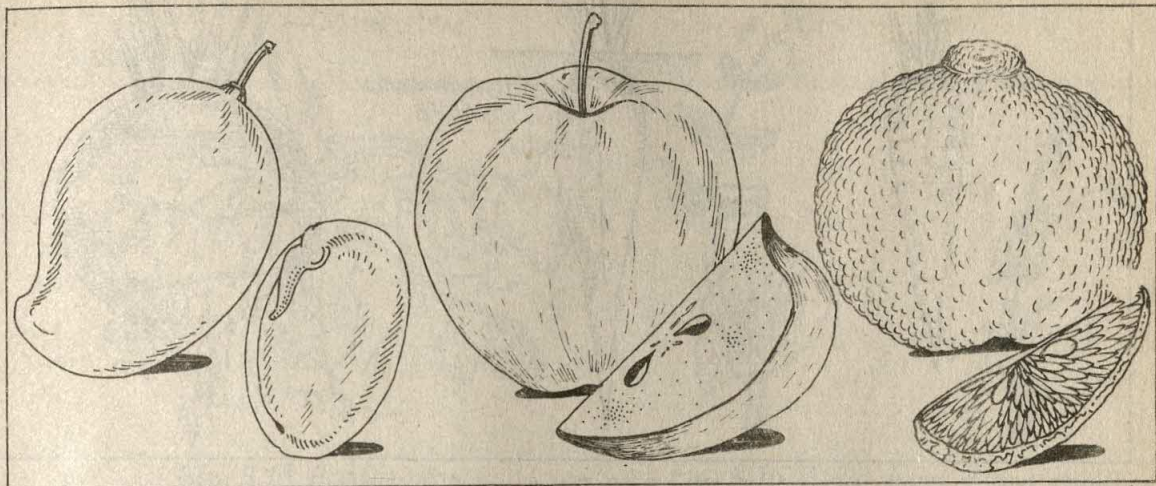


Fig. 8.11(a) Seeds of some fruits

Soak some cotton with water, put it on the saucer.

Place some gram seeds.

Put the saucer with seeds near the window. Make sure the cotton is kept soaked always. A young plant comes

out after two days or so. This shows seeds enclose a baby plant. A new plant comes out of the seed. This is called seed germination.

After studying the different functions of the different parts of the

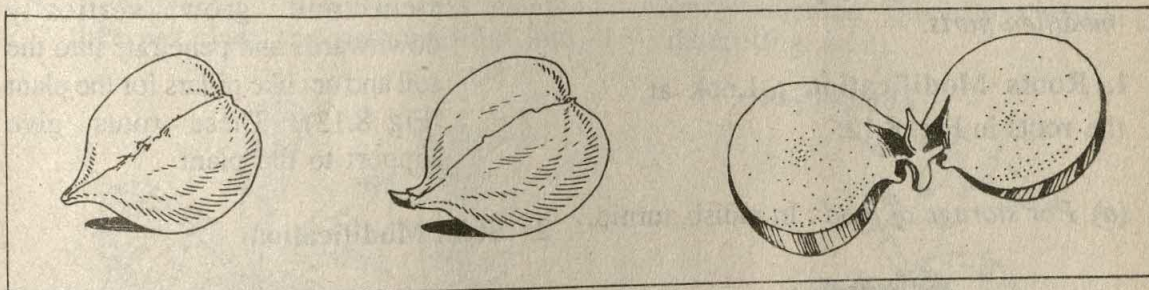


Fig. 8.11(b) Gram seed and its structure

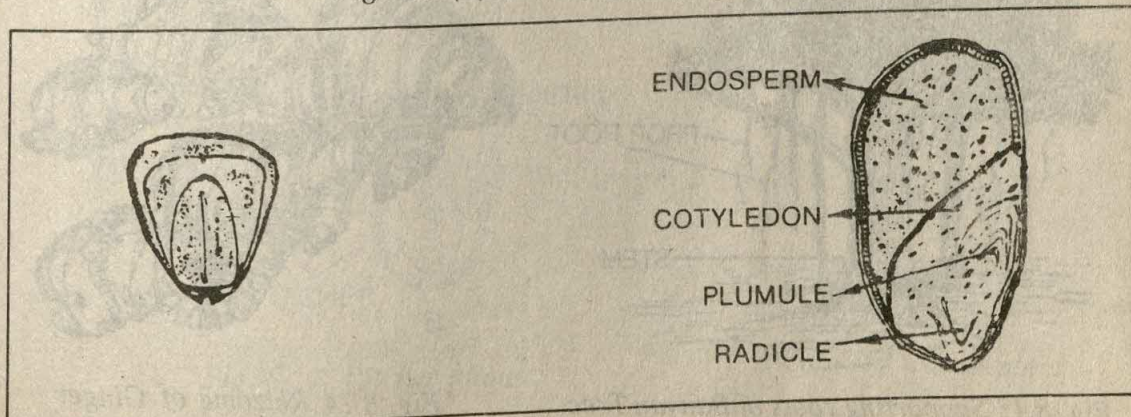


Fig. 8.11(c) Maize seed and its structure

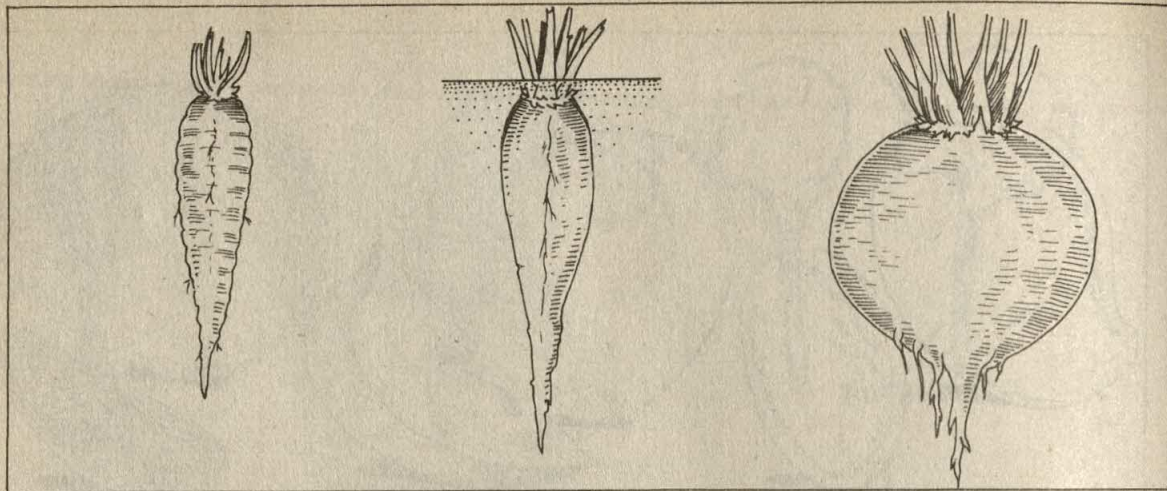


Fig. 8.12 Roots storing food

plant, we come to some other important features of the plant.

Modifications

In some plants, a particular part performs a function different from its usual function and such parts are called *modified parts*.

1. Roots Modification : Look at the roots in Fig. 8.12.

(a) *For storage of food :* In radish, turnip,

sweet potato and carrot etc., roots swell up and become different in shape. This is because food is stored in them (Fig. 8.12).

(b) *For Support :* In banyan tree the roots are produced from the main stem and grow vertically downwards and penetrate into the soil and act like pillars for the plant (Fig. 8.13). These roots give support to the plant.

2. Stem Modification

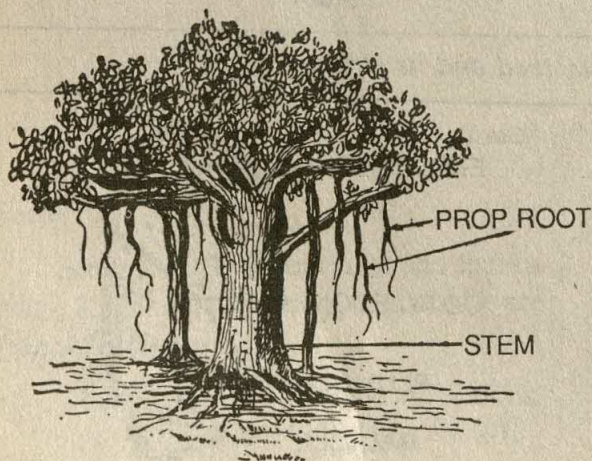


Fig. 8.13 Supporting roots of Banyan Tree

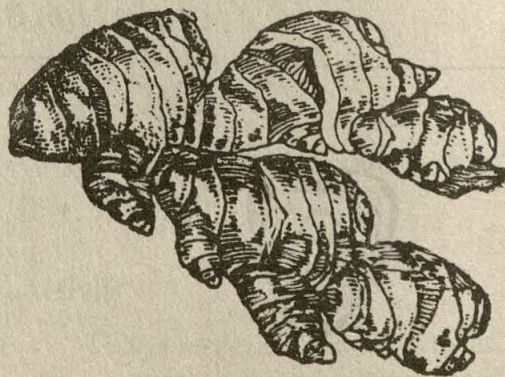


Fig. 8.14 Rhizome of Ginger

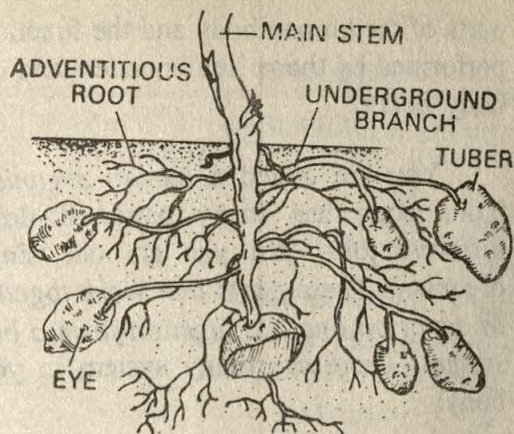


Fig. 8.15 Potato plant

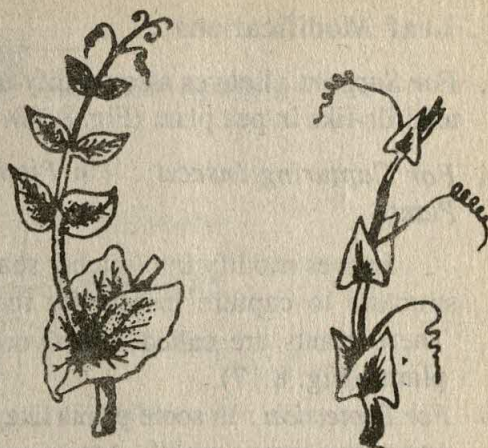


Fig. 8.16 Weak stem of pea showing tendrils

1. *For Storage of food* : In some plants, like onion, ginger and potato, stem remains under the ground and swells up because of the accumulation of food (Figs. 8.14, 8.15).
2. *For Support* : In some weak plants, like pea plant, the stem modifies into

long thread-like structures called *tendrils*. These twine around a neighbouring support and give support to the main plant (Fig. 8.16).

In plants like cactus : Stem becomes green, flattened, leaf-like and performs all the functions of a leaf. The plants stems water too. This helps the plant in desert (Fig. 8.18).

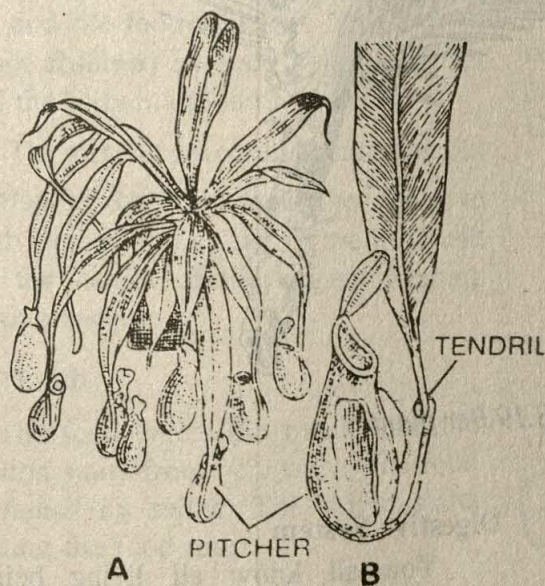


Fig. 8.17 Pitcher plant

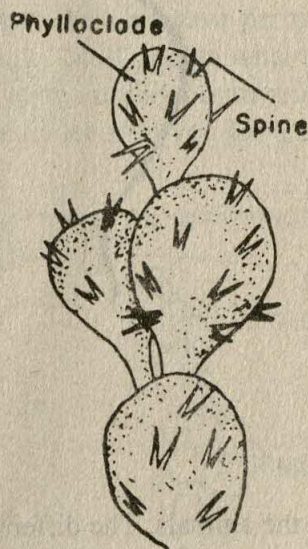


Fig. 8.18 Cactus plant

3. Leaf Modifications :

1. *For Support* : Leaves also modify into tendrils-like in pea plant (Fig. 8.16).
2. *For Capturing Insects* : (In Pitcher Plant)

Leaves modify into pitcher shape structure to capture insects for food. These plants are called insectivorous plants (Fig. 8.17).

3. *For Protection* : In some plants like ber and cactus leaves modify into spines or thorn for protection, defence, etc. (Figs. 8.18, 8.19).

8.7. Different Parts of Animals

You all know, very much like plants there is lot of variation in the different

parts of the human body and the functions performed by them. Let us understand our body better.

You are called a *human organism*. Your body has many parts, all doing different jobs, still you are one single organism. *These parts that work together to carry on one life function form a body system*. There are many system in your body.

Just as an organism like you is made up of systems, each system is made up of different parts—called *organs*. Organs work together in helping the system to do its job. Let us get to know the different systems in your body one by one.



Fig. 8.19 Ber plant

parts of the animals. The different parts of the animals perform different functions according to the need of the body. Here we shall discuss in detail about the different

Digestive System

You all know all living beings including you need food to grow, to remain healthy and above all to keep alive.

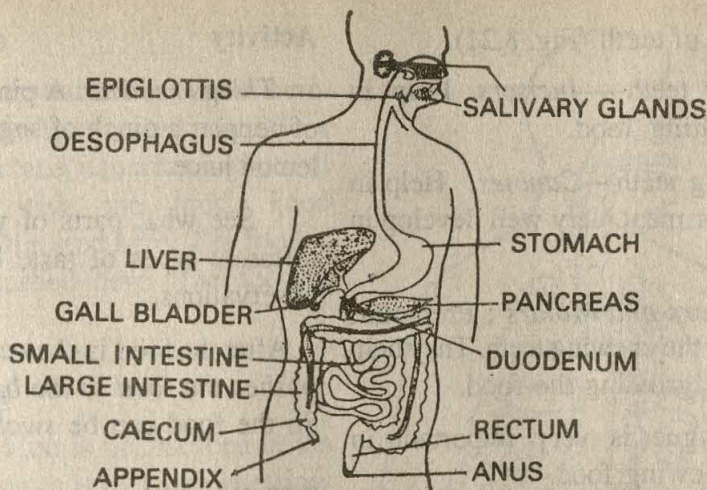


Fig. 8.20 Parts of the digestive system

An apple, a mango, an egg, a chapati, a plate of rice cannot be used by your body as they are. Quite a few changes must take place before you can actually use this food. The process in which food is broken down and dissolved so that it can be used by the body is called *digestion*.

Your body cells absorb the digested food, and the food which is not digested and not absorbed by body cells is thrown out of the body in the form of faeces.

The organs involved in carrying out digestion in the body form the digestive system Fig. 8.20. See the figure 8.20 and learn the names of the organs forming digestive system.

8.8 Mouth

The food enters the mouth and the digestion starts from here only. The food is *softened* by *saliva*. The saliva starts digesting the food too.

Saliva is secreted by *salivary glands* present in the mouth. Softened food is

chewed well with the help of teeth present in your mouth. You need strong teeth to chew your food properly. Therefore, you need to take a good care of your teeth and brush them well. Everyone has two sets of teeth during his life.

The first set of 20 teeth are *baby teeth* or *milk teeth*. The second set of teeth are *permanent teeth*. You all have permanent set of teeth now. Most people when grow up have 32 teeth in the permanent set. Count how many teeth do you have. There

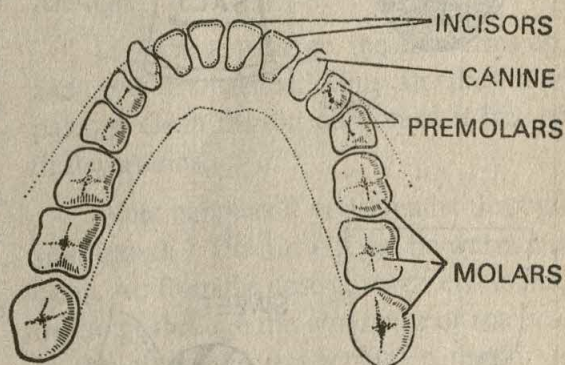


Fig. 8.21 Different types of teeth

are four types of teeth (Fig. 8.21).

1. Biting teeth—*Incisors*. Help in cutting and biting food.

2. Tearing teeth—*Canines*. Help in tearing flesh or meat. Very well develop in dogs etc.

3. *Premolars and Molars* : Premolars and molars are the chewing teeth. They help in chewing or grinding the food.

Your tongue is very important in tasting and chewing food.

The tongue moves the food around in the mouth as it is chewed. This helps in proper mixing of saliva with the food. Tongue and teeth help in clear speech.

Your tongue helps you in tasting sweet, sour, bitter and salt taste.

Your tongue has special taste buds which help you to taste the different tastes of the food. (Fig. 8.22).

Activity

Things needed : A pinch of salt; a pinch of pepper; a pinch of sugar; a few drops of lemon juice.

See what parts of your tongue have different types of taste buds. Write your observations.

After the food is chewed well, the tongue *pushes the food to the back of the mouth*. So the food can be *swallowed*.

8.10 Oesophagus

From the mouth, food comes to oesophagus, which *carries* the food to the stomach. Liquids pass quicker than the solids.

Stomach

In the stomach, the food is churned and mixed with many digestive juices. The juices carry on digestion. The food that you had eaten becomes *thick soft material*.

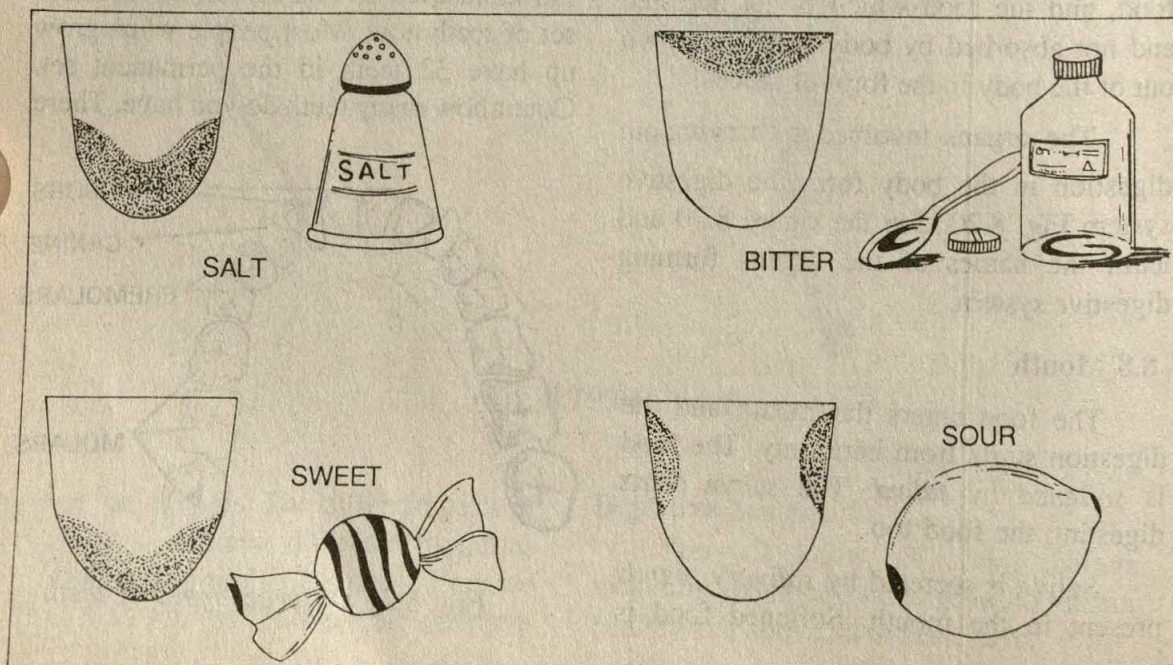


Fig. 8.22 What the tongue does for us

Small Intestines

Food from the stomach comes here. Small intestines are long coiled tube. More juices from liver and pancreas and small intestines mix with the food. Food completely gets digested here. The food is ready to be absorbed here. The food is absorbed here.

Large Intestines

The food which is unabsorbed in the small intestines comes here. Large intestines absorb maximum water from the digested food. Unabsorbed and undigested food is thrown out as faeces from the large intestines.

8.11 Respiratory System

When you run, or climb the stairs fast what happens? It goes one breath, and out goes another. What do you think is going in and out of your body so fast.

It is the air, that goes in and came out.

In the air, there are many gases. The most important gas in the air for us is *oxygen*. We need oxygen to stay alive. Oxygen helps in *breaking the absorbed food to release energy*. This process of releasing energy by breaking absorbed food is called *respiration*. As food is broken carbon dioxide is produced as a waste.

As you breathe, the air follows a special pathway into the body. Look at the Fig. 8.23. With the help of your finger, follow the arrows from the nose to the lungs.

The system by which you breathe in oxygen and breathe out carbon dioxide in the air is called *respiratory system*. The air

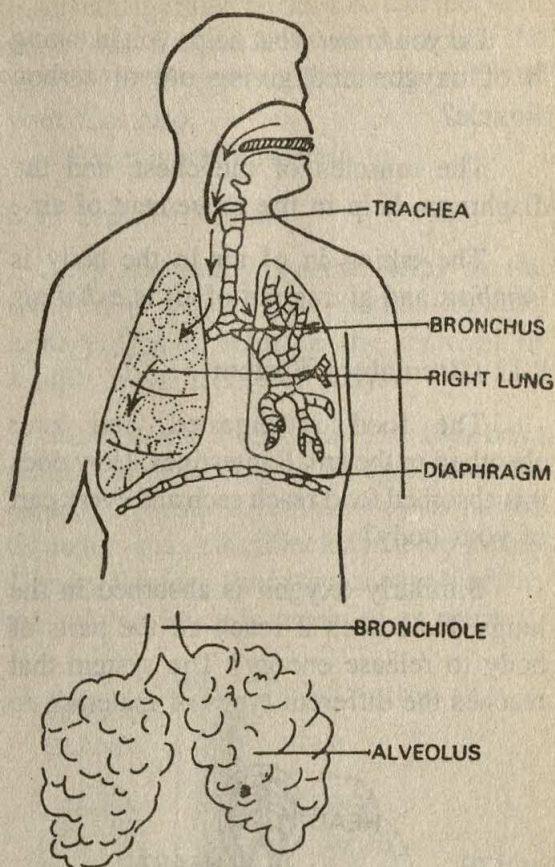


Fig. 8.23 The respiratory system

passes through the nostril into the *nose passage*.

In the nose passage, the air warms up, and gets moistened. Hair in the nose passage clean the air, and make it free of dust particles.

What happens if you breathe through your mouth? The air will not be warm and clean. Air from the nose passage, enters into the lungs through the *wind pipe or trachea*. In the lungs, the oxygen from the air is taken in and enters the blood, and from the blood carbon dioxide, and water vapours enter into the air as waste products.

Do you know what helps you in taking in of oxygen and giving out of carbon dioxide?

The muscles of the chest, and the diaphragm help in the movement of air.

The taking in of air in the body is *inhaling*, and giving out of air is *exhaling*.

8.12 Circulatory System

The food is digested, and later absorbed in the small intestines. How does this absorbed food reach each and every part of your body?

Similarly oxygen is absorbed in the lungs. How does it reach all the parts of body to release energy? The system that reaches the different types of materials to

different parts of the body is called *circulatory system*. The system is made up of tubes, hollow pump and blood (Fig. 8.24). The blood has all the materials, needed to be reached to all parts of the body. The blood is pumped to all parts through a hollow pump called *Heart*. Heart pumps the materials to all parts of the body. Size of your heart is that of your closed fist.

Activity

Make a loose fist with your left hand. Place it over the centre of your chest and pull your fist a little *to the left*. Point your thumb toward your right shoulder to make sure your fist is in the right position. This is the *place your heart* is located. You hear the beats called *heart beats*. A normal heart beats 70 to 72 times per minute.

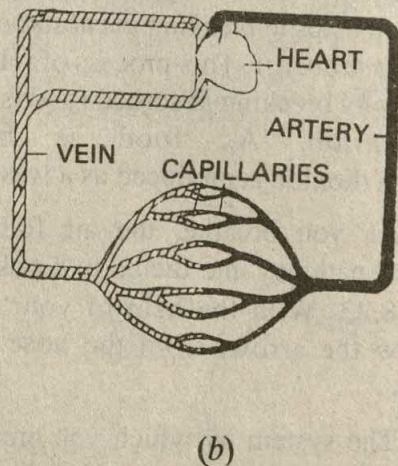
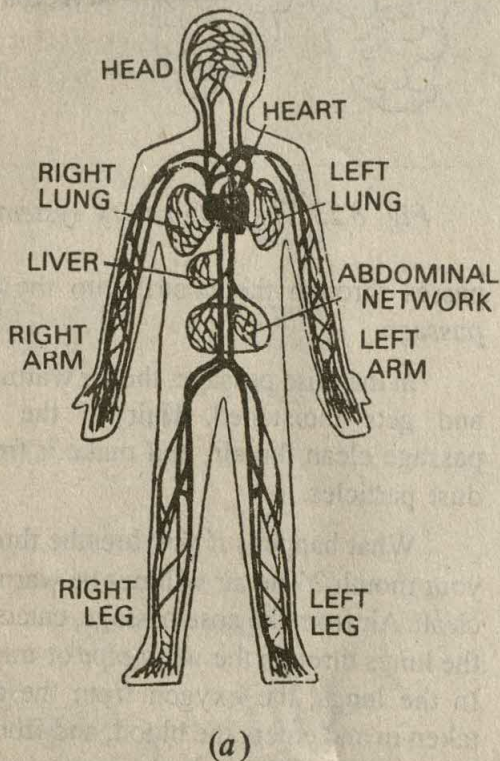


Fig. 8.24

The heart pumps the blood in the tubes called *blood vessels*.

The blood vessels which carry blood from the heart to the other parts of the body are *arteries*. The blood vessels which bring the blood to the heart from parts of the body are *veins*.

Activity

Stretch out your arm, do you see blue lines.

Ask your teachers to stretch out the arm, the blue lines may be thicker. These blue lines are *veins*.

Veins are superficial therefore can be seen. The arteries are deep seated, therefore cannot be seen.



Fig. 8.25 Counting the pulse

Activity

Let your hand bend a little at the wrist. Press the first two fingers of your other hand into the little hollow spot under the wrist just in the back of the thumbs, see Fig. 8.25.

Sit quietly so that you can feel something. The repeated pushings and beats

is something called *pulse*. You can feel your pulse beat. You can feel your pulse near the temple in the neck, and near the ankle of your foot also.

Count your pulse rate.

8.13 Urinary System

As respiratory system helps in the removal of waste, gas—carbon-dioxide, urinary system helps in the removal of soluble waste from the body.

Look at the Fig. 8.26. The two bean shaped kidneys, remove the waste from the blood. The waste from the kidneys is carried by ureters and gets collected in a bag called *Urinary Bladder*. From the urinary bladder, the soluble waste is removed as *urine*.

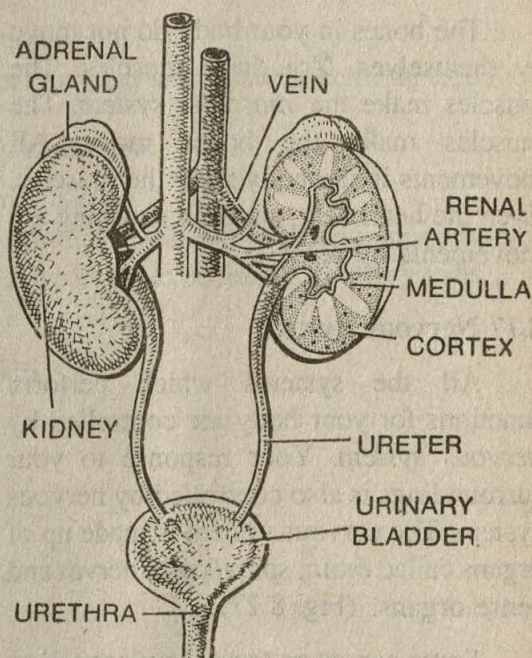


Fig. 8.26

8.14 Reproductive System

All living organisms, reproduce their kind. Human beings also reproduce their

own kind.

Animals including human beings have male and female reproductive systems helping in producing young babies.

8.15 Skeletal System

Your body has a proper shape. The bones and cartilage form the frame of the body. This frame work gives shape and support to the body. The system of bones and cartilage forming the frame work of the body is the *skeletal system*.

There are 206 bones making your skeletal system.

8.16 Muscular System

The bones in your body do not move by themselves. You have muscles. The muscles make the *muscular system*. The muscles make the bones move. All movements in the body is by the muscles. Even the heart beat, stomach churning are movements by muscles.

8.17 Nervous System

All the systems which perform functions for your body are controlled by *nervous system*. Your response to your surroundings is also controlled by nervous system. The nervous system is made up of organs called *brain*, *spinal cord*, *nerves* and sense organs. (Fig. 8.27).

Some nerves go from the place where you are pinched or felt to the spinal cord and brain. Other nerves carry *messages* from the brain and spinal cord to the muscles and make them move. By means of these nerves you perform activities as walking, talking, swimming, eating and

washing etc. Nerves are spread all over your body.

Some parts of the nervous system tell

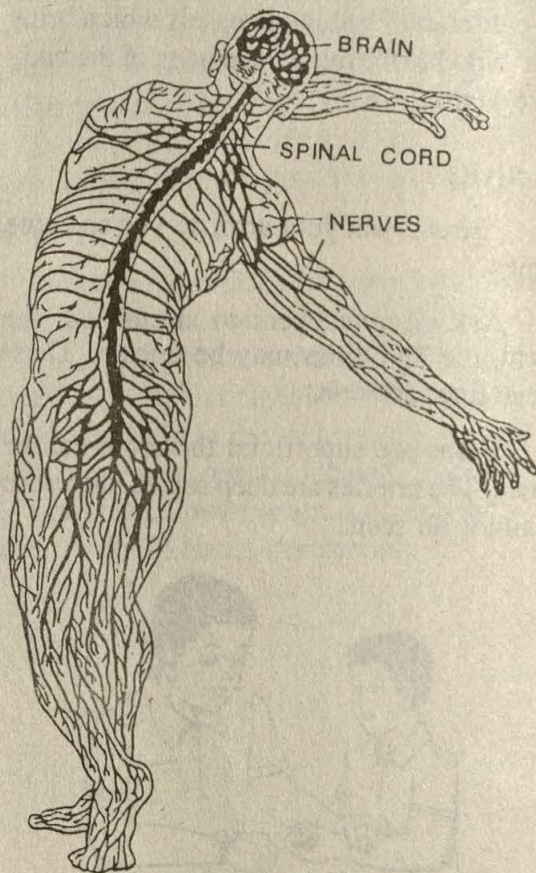


Fig. 8.27 The Nervous system

your muscles to move without your knowing, your heart muscles make the heart beat without your knowing it.

You know about the changes in your surroundings with the help of your sense organs—eyes make you see, ears make you hear, tongue makes you taste, nose makes you smell and skin makes you feel heat, cold, pain, pinch or irritation etc.

Brain and spinal cord are the controlling organs of your body. They are

kept protected. Brain is protected in the skull. Spinal cord is protected in the vertebral column.

8.17 Effect of Removal of Parts

In animal and plants it is seen that different parts have different functions to perform.

To study different functions of different parts — the practice is to remove a body organ and study the effect on the body of an organism.

See for yourself.

Activity

1. Remove all the leaves of a plant and see what happens? A plant fails to grow.
2. Hold your tongue and speak. It is not possible to speak without the movement of tongue.
3. See a man or a woman without teeth. What kind of food can they eat? It is not possible for them to eat all kinds of food without teeth.

All parts of the body have specific function to perform in plants and animals both.

SUMMARY

1. All living organisms have specific parts.
2. In plants, the specific parts differ in different plants.
3. In flowering plants—roots, stem, leaf, flower, fruit and seeds have specific function to perform.
4. Some parts of plants modify to perform special function.
5. Animals show lot of variation in structure and function.
6. Like all animals, human beings also have different systems—digestive, respiratory, circulatory, urinary, reproductive,, skeletal, muscular and nervous to perform different systems.

EXERCISES

1. Give the functions of the following:
 - (i) Roots in plants
 - (ii) Leaves
 - (iii) Flower
 - (iv) Stomach
 - (v) Lungs
 - (vi) Kidneys
2. Answer the following questions:
 - (i) What is a system ?
 - (ii) What is a digestive system ?

- (iii) What happens to the air in the nose passage ?
 - (iv) What are supporting roots?
 - (v) What are tendrils?
 - (vi) Why is cactus leaf like?
 - (vii) Name the reproductive parts of a flower.
 - (viii) How does heart help in the body?
 - (ix) How do sense organs help you?
 - (x) What are fibrous roots?
3. Name the following :
- (i) Organs which control all the body system.
 - (ii) Plants having tap roots.
 - (iii) Dicotyledon seeds.
 - (iv) Modified stem.
 - (v) Teeth help in grinding.
 - (vi) Organ where water is absorbed in the human body.
 - (vii) Blood vessels which carry blood from the heart to the body organs.
 - (viii) Tube that connects mouth cavity to the lungs.
 - (ix) Blood vessels which are superficially placed in the human body.
 - (x) Protective box of the brain.
 - (xi) Organs of urinary system.
4. Fill in the blanks :
- (i) Ginger is a modified.....
 - (ii) Radish is a modified.....
 - (iii) The process by which green plants synthesize their food is.....
 - (iv) is an organ of touch.
 - (v) develop into seeds inside the ovary.
 - (vi) system gives support and forms the framework of body in man.
 - (vii) of food is completed in
 - (viii) Leaf..... give to the weak plant.
 - (ix) You have sets of teeth..... and sets.
 - (x) is protected in the vertebral column.
 - (xi) Your heart beat is per minute.

(xii) Leaves are borne at the of stem.

(xiii) Space between two nodes is

ACTIVITIES

1. Collect the following, press them and put them in your scrap book.

- (a) 5 different kinds of leaves.
- (b) 5 different kinds of flowers.
- (c) 5 different kinds of seeds.

2. Make a record of your :

- (a) Height
- (b) No. of teeth
- (c) Kinds of teeth
- (d) Weight
- (e) Heart beat
- (f) Pulse rate



Chapter IX

AIR



Fig. 9.1 Moving air

9.1 Air

Air is all round us. Although air is invisible, there are many ways in which it can be detected. If you hold your fingers in front of your nose, you can sense air movement as you exhale. Moving air can make a tree's branches sway back and forth. And the force of air can push a balloon filled with helium high up into the sky. We live at the bottom of an ocean of air which surrounds the earth.

9.2. Composition of the Atmosphere

The atmosphere is the air which surrounds the earth and extends about 960 Km. above its surface.

Invert a glass bottle and press it into the water inside a big jar. Does the water fill the bottle?

Air occupies space and has weight. Air

is a mixture of gases, fine dust particles and water vapours. Its gases are mostly nitrogen and oxygen. About 78 percent of air is nitrogen (N_2) and about 21 percent is oxygen (O_2), making a total of 99 percent. The remaining 1 percent of the air is argon (Ar), carbon dioxide (CO_2) and minute

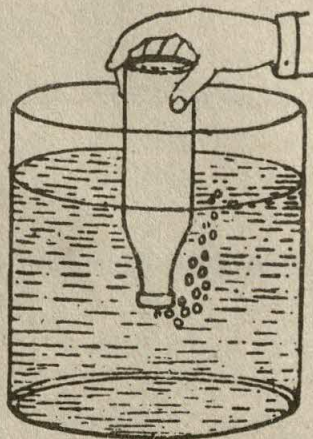


Fig. 9.2 Air bubbles rush out of an empty bottle when dipped in water

amounts of other gases.

Table : Composition of air

Gas	Percent by Volume	Minute	Amount
Nitrogen	78.09	Neon	Xenon
Oxygen	20.95	Helium	Radon
Argon	0.93	Krypton	Water Vapour
Carbon dioxide	0.03	Hydrogen	

The outer limit of the air surrounding the earth is indefinite. However, air is very dense near the surface of the earth and becomes less dense with increased altitude. This occurs because the force of gravity, the major factor that prevents the atmosphere from drifting into space, is stronger near the earth's surface.

The portion of the atmosphere about 12 Km, above the earth is called the *Troposphere*. Almost all weather activity occurs in this layer. As you leave the earth's surface and go higher in the troposphere, the temperature, continually decreases. The decrease is fairly constant.

The upper boundary of the troposphere is called the *tropopause*. Beyond the tropopause is the *stratosphere*. The upper limit of the stratosphere is called the *stratopause*. Beyond it, is an extremely thin layer of atmosphere known as the *ionosphere*. It is named ionosphere because

it contains a great concentration of electrically charged atoms called *ions*. The composition of the ionosphere is also unique because it is rich in a form of oxygen called ozone (O_3).

The ionosphere is a great aid to radio communication. Radar is one kind of radio wave which passes through the ionosphere.

Weather is the condition of the atmosphere at a particular time. Climate is the average weather over a long period of time.

The scientific study of weather and climate is called *meteorology*.

9.3. Oxygen

Oxygen is the most abundant of all the elements. It is found in the air, the sea and the land. In the air, oxygen is mostly present as the uncombined element, occupying one-fifth of the total volume. Some oxygen is dissolved in the water of the sea, providing fish and other organisms in the sea with one of their means of life.

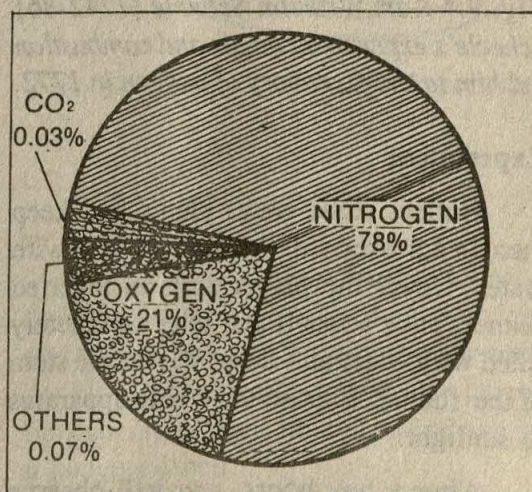


Fig. 9.3 Composition of Air

The Swedish chemist, Scheele first prepared oxygen in 1771 by heating mercuric oxide. Priestley, the well-known chemist of England, also prepared this gas. It was left to the French scientist, Lavoisier to study its properties and give it the name 'oxine' (oxygen).

The symbol of oxygen is O and its molecular formula is O_2 . Its atomic mass is 16.

9.4 Preparation of oxygen

Green plants are the source of oxygen present in our atmosphere.



Fig. 9.4 Karl Wilhelm Scheele (1742-86). Scheele's experiment on air and combustion led him to the discovery of oxygen in 1772.

Experiment

Collect some water plants and keep them in a beaker. Fill the beaker 3/4 th with water. Cover the plants with an inverted funnel. Take a small test tube completely filled with water and invert it over the stem of the funnel. Expose the whole apparatus to sunlight.

After a few hours, you will observe bubbles of gas rising with the test tube and

collecting at the top. Put a thumb at the mouth of the test tube while it is inside water and remove the test tube carefully. Now introduce a glowing match stick into the test tube. It will burst into a flame due to the presence of oxygen in the test tube.

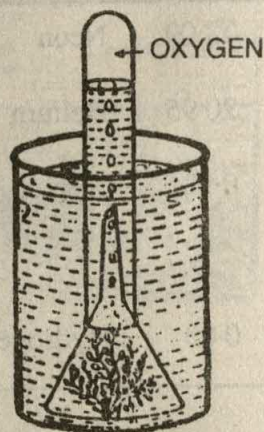


Fig. 9.5 Oxygen from green water plants

Laboratory Method

In the laboratory, oxygen gas can be prepared by heating Potassium chlorate in a hard glass test tube.

If Potassium chlorate is heated alone, it melts and then decomposes. When manganese dioxide is added to Potassium chlorate (about 1/5th of the total weight being Manganese dioxide), oxygen is given off at a much lower temperature, 200°C instead of about 600°C and at a steady rate.

The reaction is

Potassium Chlorate + Manganese dioxide
 $\longrightarrow$ Potassium Chloride + Oxygen + Manganese dioxide.

Reaction goes faster in the presence of Manganese dioxide.

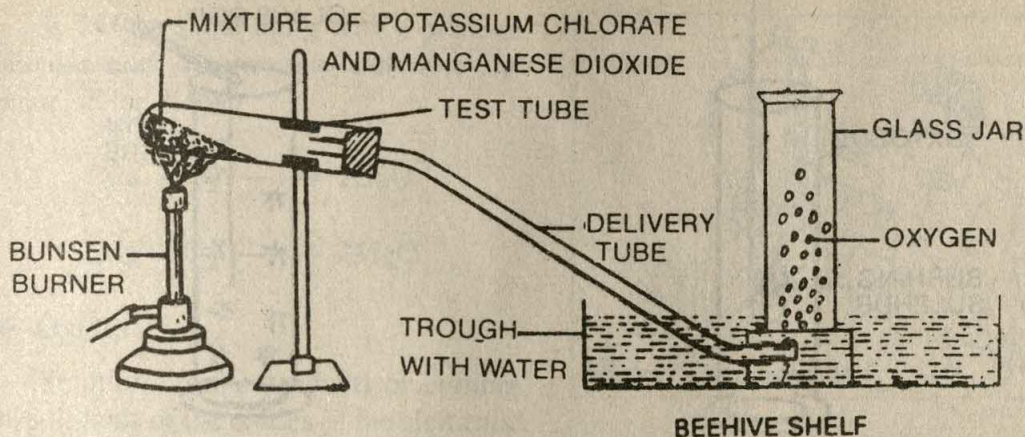


Fig. 9.6 Preparation of Oxygen in the laboratory

Collect the gas in a gas jar by downward displacement of water. In this method MnO_2 acts as a catalyst.

'A catalyst is a substance which increases the rate of a chemical change without itself undergoing any permanent chemical change'.

Copper oxide and ferric oxide will also help KClO_3 to give up its oxygen more rapidly. These substances are known as catalysts.

9.5 Properties of Oxygen

Physical Properties :

Collect the gas in several gas jars and study the following properties: (i) Colour, (ii) Smell or odour, (iii) Solubility in water.

We find that oxygen is colourless, odourless gas. It is slightly heavier than air and is slightly soluble in water. Aquatic plants and animals can live in water because of this property.

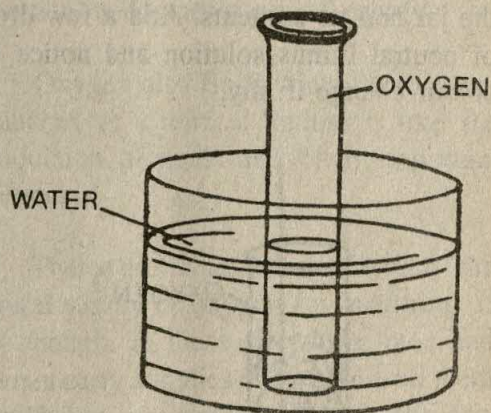
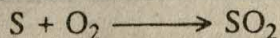


Fig. 9.7 Oxygen is very slightly soluble in water.

Chemical Properties:

1. Warm some sulphur in a deflagrating spoon until it begins to burn and then plunge the burning sulphur into a gas jar of oxygen. We observe that sulphur burns with a bright blue flame giving out a pungent smell.



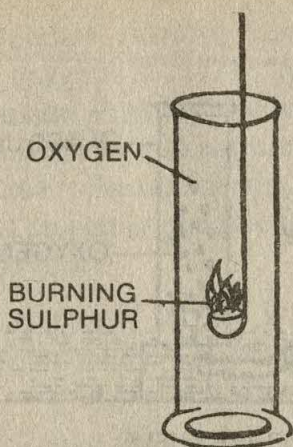


Fig. 9.8 Burning of sulphur in oxygen

When the reaction ceases, add a little water, put back the glass covers and shake the jar and its contents. Add a few drops of neutral litmus solution and notice the colour change if any.

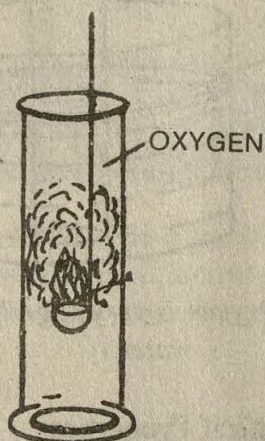


Fig. 9.9 Burning of phosphorus in oxygen

2. Put a small piece of burning Phosphorus in a deflagrating spoon into a gas jar of oxygen. What happens? The other steps are the same as those described for sulphur.

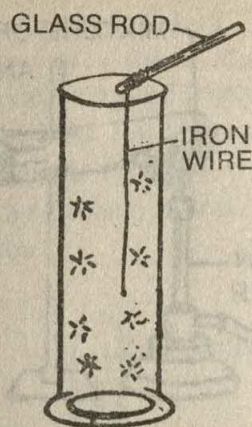
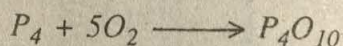


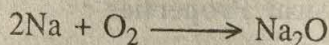
Fig. 9.10 Burning of iron in oxygen



3. Place a piece of burning charcoal on a deflagrating spoon. Heat it red hot. When the charcoal starts glowing introduce it into a gas jar of oxygen. Charcoal (carbon) burns more vigorously in oxygen liberating heat. Add a little lime water into the jar and shake. You will observe that it becomes milky.



4. Heat a small piece of sodium in a deflagrating spoon until it melts and then plunge it into a gas jar of oxygen.

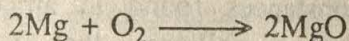
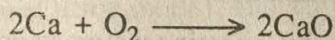


5. As a source of iron, we use steel wool and heat it to redness before plunging it into a gas jar of oxygen.



Sodium and iron burn brightly in oxygen.

6. Do the same thing with a piece of Calcium and Magnesium and note the colour of the flame.



9.6. Oxides

Solutions of the products of burning i.e., solutions of the oxides of the elements, turn the neutral litmus red or blue. No change is observed in the case of iron because the oxide in this case is insoluble in water. The non-metal oxide solutions turn litmus blue.

Litmus is known as an *indicator*. When it turns red, it indicates an *acidic solution* and when it turns blue it indicates an *alkaline solution*.

Metal oxides, when soluble, give alkaline solutions. Non-metal oxides when soluble, give acidic solutions. For metal oxides whether soluble or not, the term *basic oxides* is used. Non-metal oxides which give acidic solutions are known as *acidic oxides*.

9.7. Uses of Oxygen

Oxygen is very important for all living beings as it is needed for respiration. Without oxygen, life on the earth would have been impossible.

Fish and other aquatic animals and plants breathe oxygen that is dissolved in water. Oxygen is essential for burning oxy-acetylene flame which is used for welding and cutting metallic plates. It is also used in industry and hospitals.

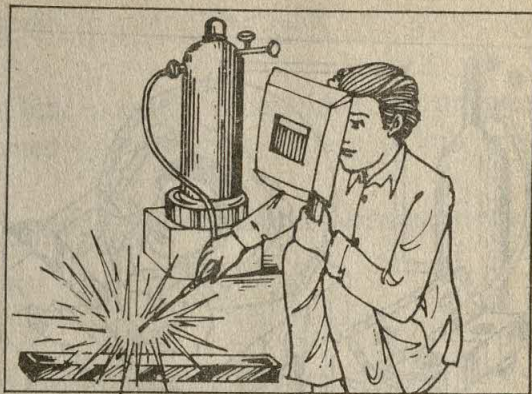


Fig. 9.11 Welding by means of oxy-acetylene flame

Combustion of fuels produces heat which may be converted into mechanical, electrical and other types of energy.

Oxygen also finds wide use in many branches of chemical industry, like the production of acids and other important chemicals.

There are situations in which the natural supply of oxygen for breathing, is not enough. In these situations, men and women carry supplies of oxygen with them in cylinders, mountaineers at high altitudes,

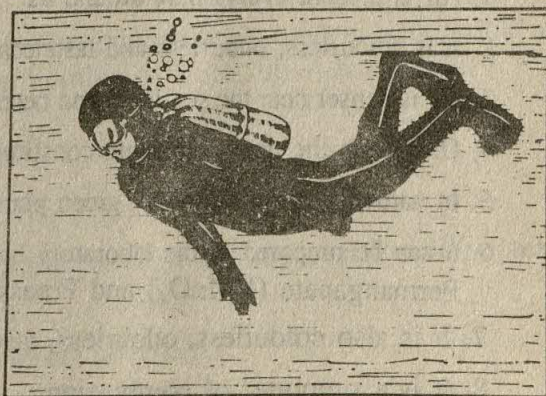


Fig. 9.12 A diver

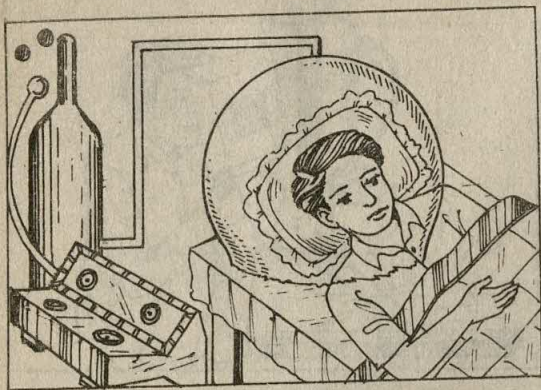


Fig. 9.13. A patient under the oxygen tent

astronauts, submariners, divers. Certain illnesses result in breathing difficulties and patients are given oxygen to breathe, either through a mask or being put in an oxygen tent.

During respiration oxygen breaks down the food to give energy, carbon dioxide gas and water vapour. Carbon dioxide gas and water vapour are used by the green plants in presence of sun light to make their food. This process is called

photosynthesis, which keeps balance of oxygen and carbon dioxide in nature.

9.8 Air Pollution

Air also contains water vapour. Any other substances found in air can be considered a pollutant, that is, waste material which is harmful to well being. Most offence is caused by fires used for cooking and heating. These fill the air with smoke, ash and sulphur-dioxide. The exhaust of poisonous carbon-dioxide, carbon monoxide, poisonous lead compounds and waste materials from factories may pollute the atmosphere. After the Industrial Revolution many of these pollutants were allowed to pollute the atmosphere without any control for their effects. Men are more conscious of their environments at the present time, and much more efforts are made to control the escape of anything which might pollute the atmosphere.

SUMMARY

1. Air is present everywhere around us.
2. It is colourless, odourless and tasteless and is a mixture of different gases.
3. Air is denser near the sea-level and becomes lighter as the height from sea-level increases.
4. Oxygen is the most important constituent of air.
5. In nature, it is produced by green plants.
6. It can be prepared in the laboratory by heating Potassium chlorate (KClO_3), Potassium Permanganate (KMnO_4) and Potassium-nitrate (KNO_3).
7. It is also colourless, odourless, tasteless and slightly soluble in water.
8. It is a supporter of combustion.
9. Carbon, Magnesium, Sodium, Sulphur etc., burn in oxygen and their oxides are formed.

10. The oxides of carbon and sulphur are acidic in nature. The oxides of sodium and magnesium are basic in nature.
11. The oxygen present in air, in presence of little moisture, reacts with iron to produce rust (iron oxide) and rusting is prevented by coating the surface of iron with suitable paints.
12. Fish and other aquatic animals and plants breathe oxygen which is dissolved state in water.
13. It is also used in industry and hospitals.
14. It is essential for burning.
15. Air is useful to man in many ways. It is used to inflating tyres of scooters, buses, motorcars, bicycles etc.
16. Carbon dioxide is needed by green plants to make their food.
17. Oxyacetylene flame is used for welding and cutting metallic plants.
18. Air can be polluted by smoke, ash and sulphur dioxide.

QUESTIONS

1. Why is air necessary for burning wood, coal etc.?
2. Give the laboratory method for the preparation of oxygen gas. Why do we use MnO_2 for this purpose ?
3. Why do we need extra oxygen supply at high altitudes?
4. What are the two essential points about a catalyst?
5. Name three abundantly occurring substances which contain oxygen?
6. Explain the use of oxygen in
 - (a) hospitals.
 - (b) mountaineering.
7. Explain with examples, the meaning of acidic and basic oxides. How would you obtain an alkaline solution from the burning of a suitable substances?
8. Explain the following terms :
 - (i) Troposphere (ii) Stratosphere
 - (iii) Ionosphere (iv) Catalyst.
9. What are the constant and variable constituents of air. List the local impurities present in air.
10. How does air reduce the harmful effect of smoke?
11. Why do mountaineers and divers carry oxygen cylinders with them ?

12. Fill in the blanks :

- (a) Air is a
 - (b) Air has and occupies space.
 - (c) The major components of air are and
 - (d) Fish and other aquatic animals and plants breathe which is
in water.
 - (e) Plants and animals maintain the balance of in all.
 - (f) is the supporter of combustion.
 - (g) Atomic weight of oxygen is
 - (h) Molecular weight of oxygen is
 - (i) Chemical symbol of oxygen is.....
 - (j) Molecular formula of oxygen is.....
 - (k) The Chemist first prepared oxygen in 1771.
 - (l) studied the properties of oxygen.
13. Tick (✓) the correct statement and cross (X) the wrong ones:
- (a) Air is a compound of many gases ().
 - (b) Oxygen does not support the combustion ().
 - (c) All living organisms breathe air to live ().
 - (d) Air helps in the movement of aircraft, birds, boats etc. ().
 - (e) Air helps in the dispersal of seeds ().

ACTIVITIES

1. Have you seen dust particles moving in a beam of light in a dark room? Where do these dust particles come from?
2. Take some lime water in a tumbler. Blow some air from your mouth by using a straw. Why does lime water change milky?
3. Cover the lighted candle with a large glass bottle with a wide mouth. After some time, why does the candle stop burning?
4. Take a small glass jar, put some water and green leaves in it. Place three or four lady birds in the glass jar. Close the jar and observe for a few days. Why do they die ?

CHAPTER X

WATER

10.1 Importance of Water

Water is the most widely spread substance on earth. Nearly three-fourths of the earth's surface is covered by oceans, seas, lakes and rivers.

We use water for many purposes for drinking, for generating electricity, for washing and cleaning, for transporting men and goods, for putting out fire and many other purposes.

We obtain water from a large number of sources : wells, ponds, tanks, lakes, rivers, springs and sea.

About 70% by weight of the human body is water. The food stuffs, vegetables, fruits we eat every day contain water. Even dry substances like dry beans, wood splinters contain water.

Large number of chemical reactions go on in living organisms, for example when we digest food. Water is very essential for life. There is no living organism on earth

that does not have water in it.

10.2 The Water Cycle

From seas, rivers, ponds etc., water evaporates due to the heat of the sun, becomes cloud, travels in the atmosphere through long distances and on cooling comes down as rain and this cycle of water goes on in nature. The rain comes down not only on the sea but also on the land.

(a) When a portion of earth's surface becomes slightly hotter than the adjoining area, the air above this portion also becomes comparatively warmer. The warm air is lighter than the atmosphere and colder air comes down to take up the space released by the rising hot air. This gives rise to an air current.

(b) Rain water is the purest form of natural water. Major part of rain water soaks into the ground and percolate deep down to the impervious rocks where it

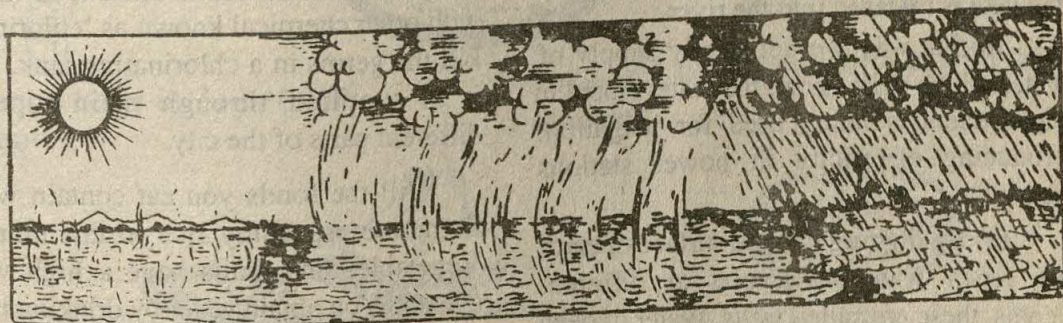


Fig. 10.1 Water cycle

accumulates. This water comes out in the form of *springs*. This water usually contains dissolved mineral salts and some gases but is free from suspended impurities.

(c) A part of the rain water forms small water currents which move from higher level to lower places. Such currents join one another to give a large current called *river*. Some rivers flow all through the year and are called *perennial rivers*.

Rivers that are formed entirely from rain water dry up soon after the rain stops. While the river is flowing, some of its water evaporates and some percolate into the ground. On its way, the water dissolves soluble substances and carries suspended impurities such as sand, clay, plants and animals.

(d) Soon after rain the springs become active and the rivers full, we see plenty of water around. If we store, we may be able to use it during the summer when water is scarce. We can store it by building a dam on the river.

The excess of water can be stored in the man-made lake which serves many purposes. Floods are controlled and the damage caused by them is avoided, when water is scarce in summer, the gates of the dam are opened and the stored water from the lake is released into the river.

In this way we get steady supply of water all the year round; the water stored in these dams is being used for irrigation, producing electricity in power stations nearby.

(e) By digging into the surface of earth we reach water reservoirs at different depths, these are called *wells*. Water of deep wells is purer than that of shallow wells.

Water from different sources has

different properties.

Sources of Water :

There are many sources of water. Oceans are the major natural source. Other



Fig. 10.2 A Well

sources are lakes, rivers, ponds, rain, underground water etc.

10.3. Purification of Water for Drinking Purpose

Water obtained from these sources is not always fit for drinking purposes. It contains many impurities and germs.

People in cities get water from taps but before the supply it is purified in many ways. The water is pumped from a lake, river or a reservoir. It is filtered through layers of sand and gravel, this tank is known as sedimentation tank. Then it is treated with other chemical known as 'chlorine' to kill the germs in a chlorinating tank. Then it is supplied through main pipes to different parts of the city.

All the foods you eat contain water. Some are especially rich in this nutrient. Vegetables and fruits have a high water content. You obtain water by drinking it and by drinking milk and juices. Some water is produced in the oxidation of food within the cells, as shown in the following equation:

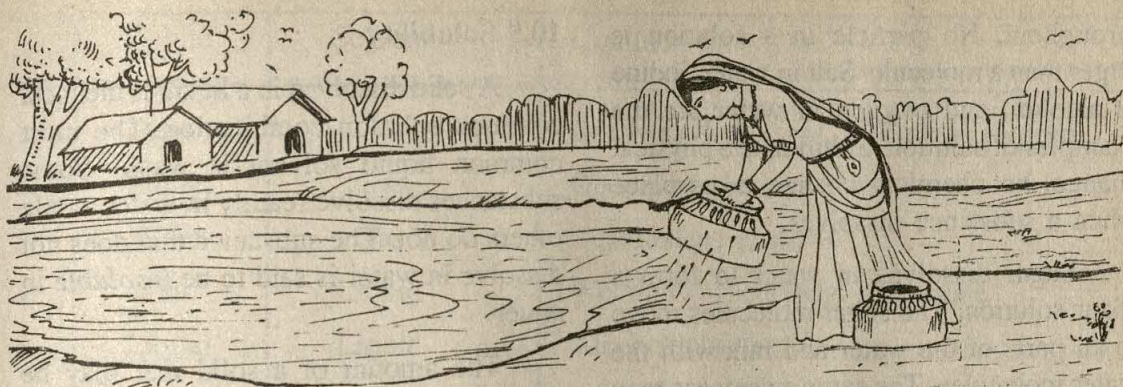
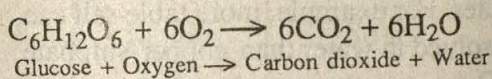


Fig. 10.3. Supply of drinking water from the river.



The percentage of water by mass present in some of the foodstuffs is given below:

Cucumber — 95%	Turnip — 88%
Meat — 75%	Potato — 75%
Egg — 73%	

Some common substances apparently look dry such as dry splinters of wood, dry

pulses, a few pieces of blotting paper, etc. If we heat these substances carefully without letting the contents char in the test tube, we will notice water droplets on the outer parts of the test tube.

10.4. Solutions

A solution is composed of two or more substances in which the particles of the substances are uniformly distributed



Human body is 70 per cent water.



Melons and lettuce contain upto 95 per cent water.



Eggs, meat and potato contain about 75 percent water.



Fig. 10.4 Percentage of water in human body and some food substances.

throughout. No particle in a solution is larger than a molecule. Salt in water, iodine in alcohol, and oxygen in water are the examples of solution. Solution is a physical change, no chemical change takes place when a substance dissolves.

Sugar dissolves in water to form a sugar solution. The sugar molecules move to all parts of the water and mix with the water molecules. The same sweetness may be tasted in all parts of the solution.

The substance that is dissolved in a solution (sugar) is called the *solute*. The substance that dissolves the solute (water) is called the *solvent*.

solute + solvent $\rightarrow$ solution

A solute generally lowers the freezing point of a solvent in which it is dissolved. For this reason, anti-freeze (solute) may be added to water (solvent) in automobile radiators. However, the addition of solute to a solvent raises the boiling point. Table 1 gives some common examples of solutions.

Suspensions

A mixture of solid and liquid material does not always produce a true solution. Frequently, when a solid and a liquid are mixed, a suspension is formed. A suspension is a state of a substance in which its particles are mixed but not dissolved. Sometimes the particles in a suspension are microscopic. Sand and oil do not dissolve. Water, on being shaken with sand or oil becomes turbid due to the fine solid particles of sand or minute droplets of oil which remain suspended in water. Such a mixture is called a *suspensions*.

10.5 Solubility

A solid dissolved in a liquid is the most common solution combination. The most common liquid solvent is water. Some substances dissolve readily in water, while others do not. The substance that does not dissolve in water is said to be *insoluble* in water.

The amount of a solid that may be dissolved in water depends largely upon the nature of the solid and the temperature of the water. For example, more table salt can be dissolved in water than copper sulphate (CuSO_4).

The solubility of a solute is the amount of the solute that can be dissolved in a given amount of a certain solvent.

When a solvent has dissolved the maximum amount of solute at a given temperature, it is said to be a *saturated solution*.

If additional solute is added to a saturated solution, the solute does not dissolve. It sinks to the bottom of the solution where it remains.

The solution in which some more quantity of the solute can be dissolved at a fixed temperature is called an *unsaturated solution*.

A *super saturated* solution contains more dissolved solute than the amount it would normally take to saturate it. A super saturated solution is often prepared by cooling a hot saturated solution very carefully to avoid separation of the excess solute.

10.6. Solubility of Gases

The solubility of gases in liquids is

	Solute	Solvent	Common Example
1.	Gas	Gas	Deep-sea divers gas, Helium in oxygen
2.	Liquid	Gas	Open perfume bottle
3.	Solid	Gas	Naphthalene in oil
4.	Gas	Liquid	Welding — acetylene in acetone
5.	Liquid	Liquid	Alcohol in water
6.	Solid	Liquid	Sea water — salt in water
7.	Gas	Solid	Gas stone lighter—hydrogen in palladium
8.	Liquid	Solid	Dental—mercury in cadmium
9.	Solid	Solid	Ornaments — silver in gold

affected by the nature of the gas, temperature of the gas, and the pressure of the gas. Some gases are more soluble than others.

A glass of the tap water often appears milky. This appearance is caused by tiny air bubbles in the water produced when some dissolved air is forced out from the water as it is heated. Air is a mixture of gases. As the water warms, air is released from solution and tiny bubbles are formed. The release of air bubbles from warm water shows that gases are less soluble in warm water than in cold water.

If a large amount of solute is present per unit volume, the solution is a *concentrated solution*. If only a small amount of solute is present per unit volume, the solution is a *dilute solution*.

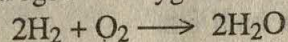
10.7. Composition of Water

During the electrolysis of water,

oxygen and hydrogen gases are liberated.

The composition of water is

Hydrogen + Oxygen $\longrightarrow$ Water



2 volumes 1 volume 2 volumes

Thus 2 volumes of hydrogen need 1 volume of oxygen to form 2 volumes of water. That is, the ratio of oxygen to hydrogen by volume in water is 1 : 2.

The mass of hydrogen atom is 1 and that of oxygen is 16. Thus the ratio of hydrogen to oxygen in water by mass is 2 : 16 i.e., 1 : 8.

The ratio of hydrogen to oxygen remains constant in any sample of water.

10.8. What is in the water we use?

Water from different natural sources is not the same. In fact, no natural source of water gives us pure water. Water from different sources differ in the nature and

amount of these materials.

Sea water contains largest amount of dissolved impurities about 3.5% dissolved salts and about 2.8% common salt (Sodium chloride).

The nature of the substances dissolved in fresh water varies from place to place. In some places it is easy to produce lather with soap but in some it does not give lather so easily. Water in which soap lathers well is called *soft water*.

Water in which soap does not do so is called *hard water*.

Hard water is found in many areas. It causes several problems. For example, when it is used with soap to wash clothes, the hard water causes the soap to become insoluble. This results in a scum-forming on the clothes. Hard water is responsible for the formation of ring around the inside of a wash bowl or bath tub.

Another disadvantage of hard water is that it leaves a scaly, mineral deposit in water boilers and in kitchen utensils used to heat hard water.

Causes of Hardness

Hard water contains dissolved calcium, iron, or magnesium. Soft water is nearly free from dissolved minerals. So it is due to the presence of calcium chloride, magnesium chloride, calcium and magnesium sulphate, calcium and magnesium bicarbonate.

10.9 Removal of Hardness

Hardness can be removed by boiling. Temporary hardness can be removed by Clark's process. This involves the addition

of a carefully calculated amount of calcium hydroxide so that calcium is removed as the insoluble carbonate.

For the removal of the other salts like sulphates and chlorides of calcium and magnesium we use a method called permutit process.

Washing soda (sodium carbonate) is one of the compound used to remove dissolved calcium from hard water.

There are some advantages of hard water also. For bone and teeth, formation of calcium is an essential item of diet and so the best drinking water contains calcium.

10.10. Properties of Water

Pure water is a colourless, odourless, tasteless and a transparent liquid. It's freezing point is 0°C and boiling point is 100°C . Its density is highest at 4°C which is 1 gm/wl. Above and below the temperature the density of water is low and because of this the plants in water and aquatic animals also survive during winter in cold countries.

Melting of Ice

Set up the apparatus as shown in the figure. Take some crushed ice in the funnel, fitted with the thermometer. Measure the temperature of the ice. When ice melts, it changes into water. Note the temperature. You will find that it melts at 0°C . This temperature is called the *melting point*.

Boiling of Water

Set up the apparatus as shown in the figure. Now heat the water in the test tube

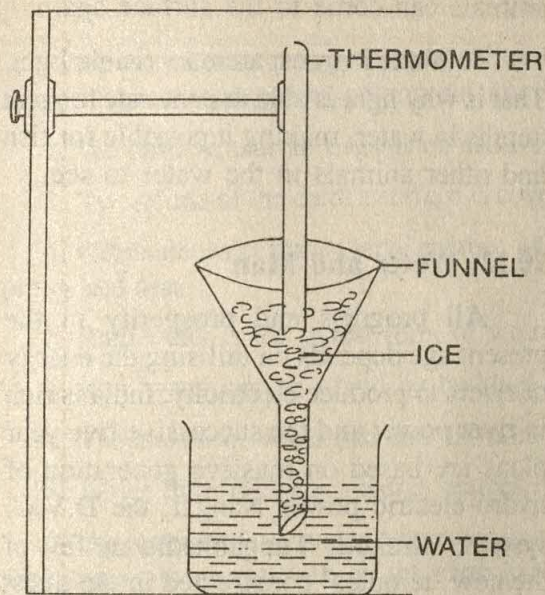


Fig. 10.5 Melting of ice

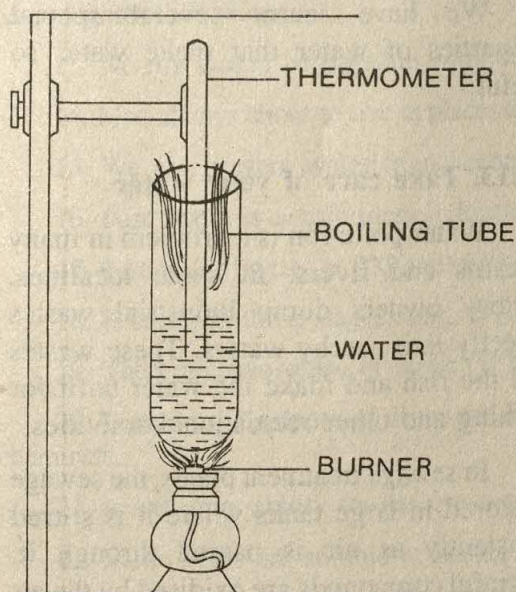


Fig. 10.6 Boiling of water

temperature is the boiling point of water. It is that temperature at which a liquid boils.

10.11. Water Purification

Water from any natural surroundings is seldom safe to drink. It must be purified before it can be used for drinking water and industry. Purification of water is accomplished with chemical compounds, chemical reactions and physical changes.

Examine a sample of river water. You see particles of clay, sand and small plants and minute animals floating or suspended in the water. Water that is safe for drinking is clear, colourless, pleasant tasting and free from harmful bacteria.

The water obtained during distillation is called *distilled water*. It is pure water because it contains neither dissolved mineral water nor bacteria. Water distillation involves the physical changes *i.e.*, evaporation and condensation. When a liquid is boiled, it changes to its vapours which can be condensed back to a liquid by cooling it. This process is known as *distillation*.

The addition of heat energy to reach the boiling point changes water to water vapour. Further heating the water kills most of the bacteria. The suspended oil particles and dissolved mineral salt or minerals present in the water remain in the flask. Water vapour passing through the condenser tube is cooled by the cold water jacket. As the vapour cools, it condenses to pure liquid water.

Distilled water, being the purest form of water, is used for preparing medicines, in car batteries and to make laboratory solutions. This water is not generally used

until it boils. You will see that the temperature steadily rise, upto 100°C . This

for drinking purposes as it does not contain mineral substances and is tasteless.

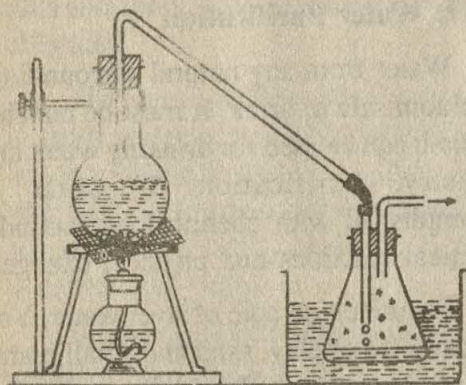


Fig. 10.7 Distillation

What makes water so useful?

1. It can dissolve a very large number of substances, that is to say, it is one of the best solvents known.

2. It does not become thinner when we heat it or thicker when we cool it. Can you say what would have happened to living organisms such as plants, if water becomes very thick on cooling and thin on heating?

3. Solid forms of most materials are heavier than their liquid forms. In the case of water, ice is lighter than water, therefore, floats on water. During winter, a lot of water freezes into ice in the Polar Regions. Ice is also a bad conductor of heat. The frozen layer of the ice, therefore, protects the liquid water below it from the cold outside and it does not allow the heat of water below it to go out. Therefore, only the top part of the water remains frozen. The water below the layer of ice stays comparatively warm. It is in this water that the fish, and rest of the aquatic animals, live through the winter. When summer comes, the ice melts and the

animals can come to the surface again.

4. Water is transparent to visible light. That is why light is able to penetrate to great depths in water, making it possible for fish and other animals in the water to see.

10.12. Water and Man

All progress and prosperity in the present age depends on utilising the energy of rivers to produce electricity. India is rich in river power and the successive five year plans are based on massive generation of hydro-electric power Nangal, the D.V.C. system, Hirakud, Tungabhadra are few of the new 'temples' constructed in the quest for power.

We know that water has ability to dissolve many substances.

We have learnt several special properties of water that make water so useful.

10.13. Take care of your water

Water pollution is a problem in many streams and rivers. In some localities, factory owners dump industrial wastes directly into nearby waters. These wastes kill the fish and make the water unfit for bathing and other recreational activities.

In sewage treatment plants, the sewage is stored in large tanks where it is stirred constantly as air is passed through it. Harmful compounds are oxidised by the air to form harmless substances. When the process is completed, the sewage may be dumped into river and ocean waters without harmful effects and can be used even for irrigation.

SUMMARY

1. We use water for many purposes such as drinking, washing and cleaning, generating electricity, transporting men and goods, putting out fire etc.
2. We observe that all organisms use water and depend on water for their life.
3. Two-thirds of the earth's surface is covered with water.
4. We obtain water from a large number of sources like wells, ponds, tanks, lakes, rivers, springs and seas.
5. Rain water is the purest form of water.
6. Rain water can be stored by building a dam on the river.
7. The excess of water can also be stored in the man-made lake.
8. Water from different natural sources is not the same.
9. The water cycle — water evaporates from a large number of sources — condenses, forms the cloud and again comes back on the earth in the form of the rains.
10. There are two types of water - Hard water and Soft water.
11. Water possesses several special properties that make it so useful.
12. Solid forms of most materials are heavier than their liquid forms but in case of water, ice is lighter than water.
13. No life would be possible without water.
14. Man always chose to live at places that were near water.
15. We can prevent water from becoming impure.
16. Pure water is a colourless, odourless, tasteless and a transparent liquid.
17. Pure water freezes at 0°C and boils at 100°C .
18. It exists in three stages solid, liquid and gas.
19. There are two types of water (i) Hard, (ii) Soft.
20. Temporary hardness of water can be removed by boiling and permanent by adding some chemicals.
21. It has great ability to dissolve many substances.
22. Some gases are soluble in water, some are not.
23. Solubility of substances in water increases with temperature.

QUESTIONS

1. Name the largest source of water on the earth.

2. Is all water which we obtain from different sources at different places the same?
3. Natural water is never pure. Why?
4. Name the two physical changes that occur in the water cycle.
5. How does the water cycle purify water?
6. What are perennial rivers?
7. How are springs formed?
8. How are rivers formed?
9. What gives rise to air currents?
10. How will you determine the melting point of ice?
11. How will you determine the boiling point of water ?
12. Name the three states in which water exists.
13. How is water polluted? Name any two pollutants.
14. Why is hard water not preferred for washing clothes?
15. Give differences between hard and soft water.
16. How does frozen water help the aquatic life in polar regions?
17. Fill in the blanks with suitable words :
 1. Water occurs in three different forms :
 - (1).....
 - (2).....
 - (3).....
 2. When changes to it is called condensation.
 3. Fast moving water has a lot of energy called
 4. Water does not become when we heat it or when we cool it.
 5. form of water is than its liquid form.
 6. Drinking water for big cities usually comes from which contains both and impurities.
 7. The hardness of water is due to.....dissolved in it.
 8. Water is a good.....
 9. Water freezes into ice at.....
 10. Water boils at.....
18. Tick (✓) the correct statement and (X) the wrong ones :
 - (a) Water is a compound. ()
 - (b) Natural water contains many impurities. ()
 - (c) Many plants and animals can live without water. ()

- (d) Hard water is suitable for washing clothes. ()
(e) Impure water boils at 101°C . ()
(f) Pure water freezes at 0°C . ()
(g) Pure water is a colourless but has a sweet taste. ()

ACTIVITIES

1. Observe for a few days what happens when you stop watering a plant grown in a flowering pot. What does this experiment show?

2. Make a list of substances which can dissolve in water easily.

3. Take leaves of any plant and weigh them. Allow them to dry in the Sun and again weigh them. Write down your observation.

4. Collect water from different sources such as from the tap, hand-pump, well, river, pond etc. Try to produce lather with soap using the different water samples. On the basis of your observations arrange the water samples in the increasing order of their hardness.

CHAPTER XI

ENERGY

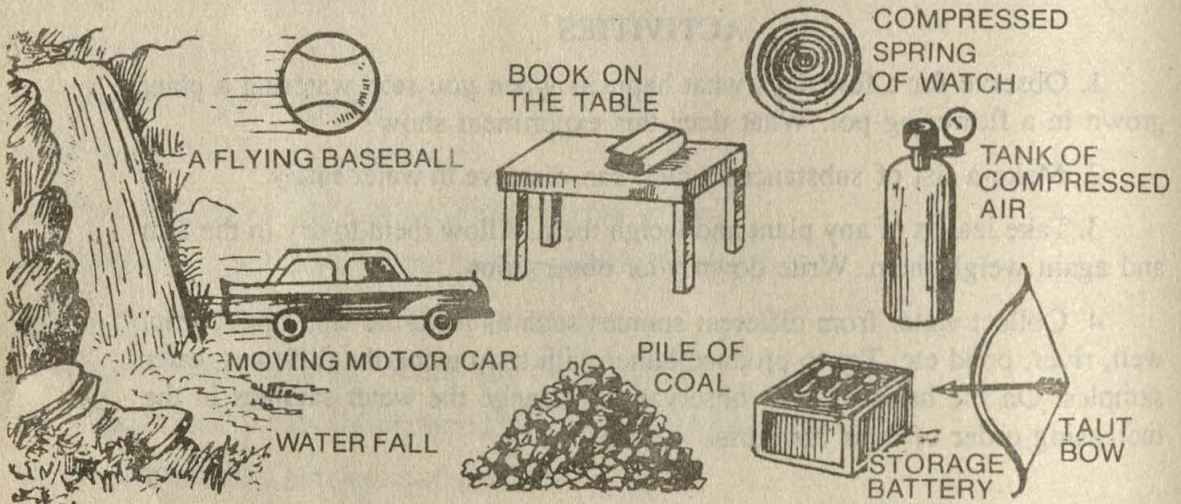


Fig. 11.1 Various forms of Energy

11.1 Energy and Motion (or Work)

Energy is the ability to do Work

We recognize energy by what it does. It can push or pull or cause motion. It can also heat our homes, cook our food and bring us television. When we work for some time we feel tired. When we are tired, our ability to work decreases. After a hard game of a long swim, one often feels : "Oh, I am tired; I have no energy left." *It appears that energy and doing work are related.* Energy is always required for doing work or for exerting a force. Our daily life is full of motion and since we need a force to move something energy is, therefore, essential for moving anything or doing work.

11.2 Mechanical Work and its Measurement

Whenever a force is applied on a body and there is a change in shape, volume or position of the body, the force is said to have done work . Work is measured by the product of the force and distance through which the point of application of the force moves in the direction of the force.

$$\text{Work done} = \text{Force} \times \text{distance moved in the direction of force}$$

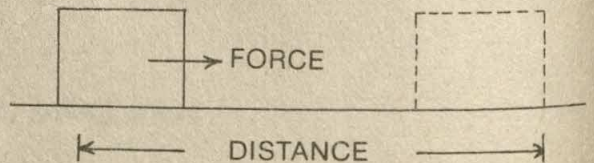


Fig. 11.2

If the point of application of force does

not move any distance (direct or indirect) in the direction of the force, *no work is done*. Therefore, work in the scientific sense means an *achievement* and not a mere effort as used in daily language.

When we twist a wire and change its shape, work is done against internal forces between the molecules of the wire. When we press a football bladder, we change its volume and work is done against the pressure of the gas in the bladder. When we push a cycle, we change its position and work is done against the force of friction between the wheels and their axles etc.

When a man is carrying a hand bag to the railway station and is walking on a level road, scientifically he is doing no work because the force that he is applying against the weight of the bag is vertically upwards and his motion is in the horizontal direction and there is no motion in the direction of the force he is applying.

A labourer, who is carrying the bricks to the roof of the house is doing more work than the mason who is raising them through

a very small distance and is simply placing them in the horizontal rows.

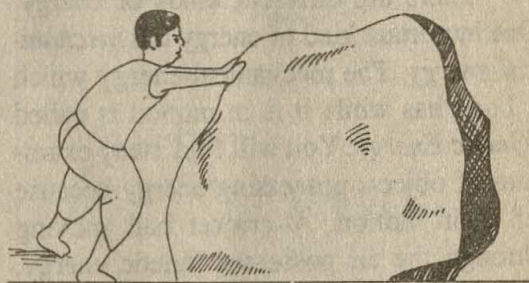


Fig. 11.3

If some one tries to push a big stone and he fails to do so, he is doing no work even though he gets exhausted (Fig. 11.2). The reason is that there is no motion in the direction of the force he is applying.

It can, therefore, be concluded that mechanical work done depends upon two factors :

- (i) The magnitude of the force applied to move the object; and
- (ii) The distance moved by the object

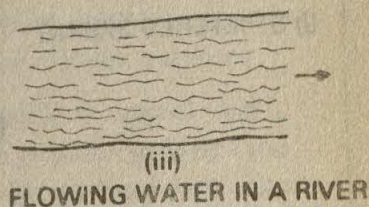


Fig. 11.4 Kinetic energy

in the direction of the force applied.

11.3. Various Forms of Energy

There are different kinds of energy. One important kind of energy is a *mechanical energy*. The mechanical energy which a body has while it is in motion is called *Kinetic Energy*. You will find many examples of objects possessing energy because of their motion. A cricket ball moving through the air possesses kinetic energy, since it is in motion. Flowing water in rivers; a moving car; moving air; moving arrow etc., possess kinetic energy.

A heavy object suspended by a string from the ceiling in your class room would also have a form of mechanical energy. You would not want to sit under such a heavy object while some one cut the string. *The kind of energy which some objects have while at rest is called potential energy*. An easy way to remember this is to imagine that objects at rest may have energy of position or some kind of stored energy. If you pick a brick from the floor and let it

fall upon a thin wooden plank, the plank breaks because of potential energy of the brick. A wound up spring, a stretched string; a stretched bow with an arrow, water on the top of a mountain, a stretched rubber catapult with a stone in it, a simple pendulum held by hand at one of its extreme positions etc., are more examples of potential energy.

It is important to note that the potential energy of a body at rest varies with respect to its position. The potential energy of a book [Fig. 11.6 (i)] held above a table is with respect to the table is *less* as compared to it with respect to the floor of a room. The earth itself has potential energy with respect to the sun [Fig. 11.6 (ii) & (iii)]. Hence, we should be careful to interpret the position of the body properly in the problem at hand.

Energy is stored in coal and other fuels such as petrol, kerosene. If you cause the coal or petrol to burn, you change the potential energy into heat energy. The heat energy can readily cause something to move and thus produce kinetic energy. Food

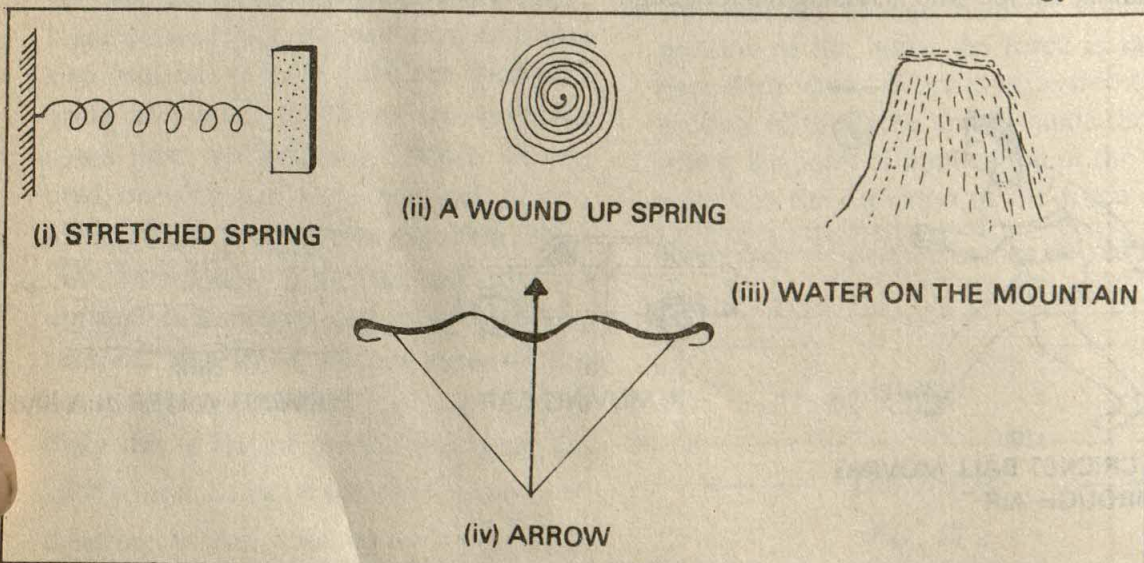


Fig. 11.5 Potential energy

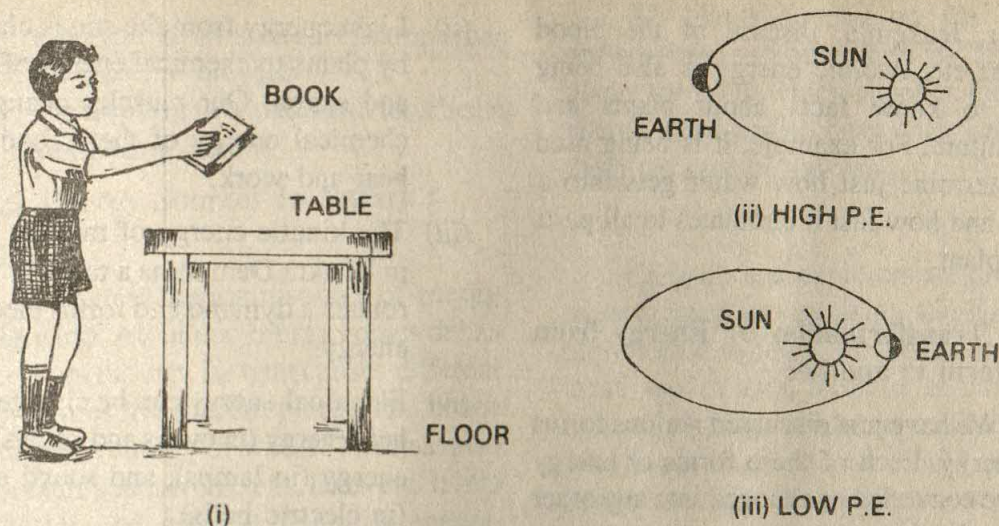


Fig. 11.6

enables us not only to breathe and think but also allows us to do things like running; climbing stairs, carrying books to school or playing a game etc. Just as motor car needs fuel to run so do our bodies need fuel which is supplied in the form of food. Can you tell what type of fuel is used in a torch giving light or in a refrigerator which keeps things cold? We see that all useful jobs require energy for the job to be done and this energy is supplied by fuel.

Some other forms of energy besides mechanical energy (Kinetic and Potential) are *heat, sound, light, chemical, electrical, and magnetic and atomic energy.*

When we burn a fuel say kerosene, or coal or cowdung or gas, we get both heat and light energy. The match head of a match stick possesses chemical energy. Coal, petrol oil, gun powder also possess chemical energy. When sitar player plucks the tight string, it begins to vibrate and produces sound energy. We use electrical energy widely in industry and at home. Can you

name a few appliances which work on electricity? Another type of energy known to us in magnetic energy which is evident from the fact that magnets attract objects made up of iron, steel etc.

Scientists have realized that atoms have energy hidden in them. This is called *atomic energy*. Most of the energy of the sun and the stars, is atomic energy. The sun and the stars convert atomic energy into heat and light that we get from them. Man must carefully control atomic energy otherwise it will destroy him. You probably have heard of the *Atom bomb* and the *Hydrogen bomb*, where atomic energy can be used for great destructive purposes.

It is today possible to control atomic energy and use it for peaceful purposes and to secure better living in the future. The plants that convert atomic energy into electricity are called *atomic power plants*. India has at present such plants in Trombay (Bombay) and Tarapur. Atomic energy is being used to learn more about diseases like

cancer, leukemia, disease of the blood system etc. Atomic energy is also being used to know facts about plants and agriculture. For example, it is being used to determine just how water gets into a plant and how fast it circulates to all parts of a plant.

11.4. Transformation of Energy from one form to another

We have just discussed various forms of energy. Each of these forms of energy can be converted or changed into any other form of energy.

Energy of position or stored energy can be changed into energy of motion. Similarly, energy of motion can be changed into stored energy. A parked car has stored or potential energy. When the driver drives the car he is changing several forms of stored energy of motion. Some of the petrol stored in the tank is being burnt to furnish heat and mechanical energy. As the car moves along the road, it has energy of motion. The battery in the car has electrical energy stored in it. This electrical energy can be changed into energy of motion.

Your own body is constantly changing energy from one form to another. Some of the food you eat is stored in your body. As you become more active this stored energy is converted into heat and mechanical energy to help your body live and work. Some more examples of the ways in which energy is changed from one form into another are as follows :

(i) The potential energy of a clock spring changes to the kinetic energy of the wheels and hands of the clock.

(ii) Light energy from the sun is changed by plants to chemical energy of sugar and starch. Our muscles change the chemical energy of these foods into heat and work.

(iii) The kinetic energy of moving water in Bhakra Dam turns a turbine, which rotates a dynamo and forms electrical energy.

(iv) Electrical energy can be changed into heat energy (in ovens and kettles), light energy (in lamps), and sound energy (in electric bells).

(v) Potential and kinetic energy change into each other when a simple pendulum swings. At the top of its swing all the energy is potential; at the bottom, all is kinetic energy. Between the top and the bottom, its energy is partly kinetic and partly potential.

(vi) In a steam engine, the chemical energy stored in the coal is changed into heat. The heat is taken by water in the boiler which changes to steam. The energy possessed by steam pushes the piston in the cylinder, thus changing into kinetic energy.

Activity

Hammer a piece of iron a few times. Touch the piece of iron, you will find that it has become warm. What are the energy changes ?

Activity

Do the following experiments and record the energy changes that take place :

(i) Work an electric bell with a battery.

- (ii) A bicycle dynamo lights a lamp when we ride the bicycle.
- (iii) Tie a spring to a stand and let a heavy stone hang from it.

11.5. Energy Sources In Nature :

1. Sun

The sun is the main source of energy on the earth. All of our energy comes or has come from the sun. Its heat causes different air pressures in different places, and hence supplies the energy of winds. The heat also evaporates water from seas, lakes etc. It lifts the water and gives it potential energy. When the water falls as rain, some of its energy can make an electricity or turn water-wheels. Plants use the sun's energy to form starch and sugar by photosynthesis.

Carbon dioxide + Water + Energy of Sunlight = Sugar + Oxygen.

All plants depend on the sun for growth. Man and other animals depend on plants for food, which supplies them with energy. Coal and oil have energy stored in them because of the sun.

Campers and explorers are often able to start campfires by using sun-light. The lens is able to focus the light rays into a small spot or area. Because of this, paper or wood shavings can be set on fire. People who live in warm climates could make use of sun's energy. On top of their roofs they might set out large tubes which are filled with water. Within a few hours the water would be sufficiently hot for bathing or other cleaning purposes. Large saucer-like mirrors reflect the sun's rays on to tubes containing water. The heat boils the water and turns into steam. We have these days

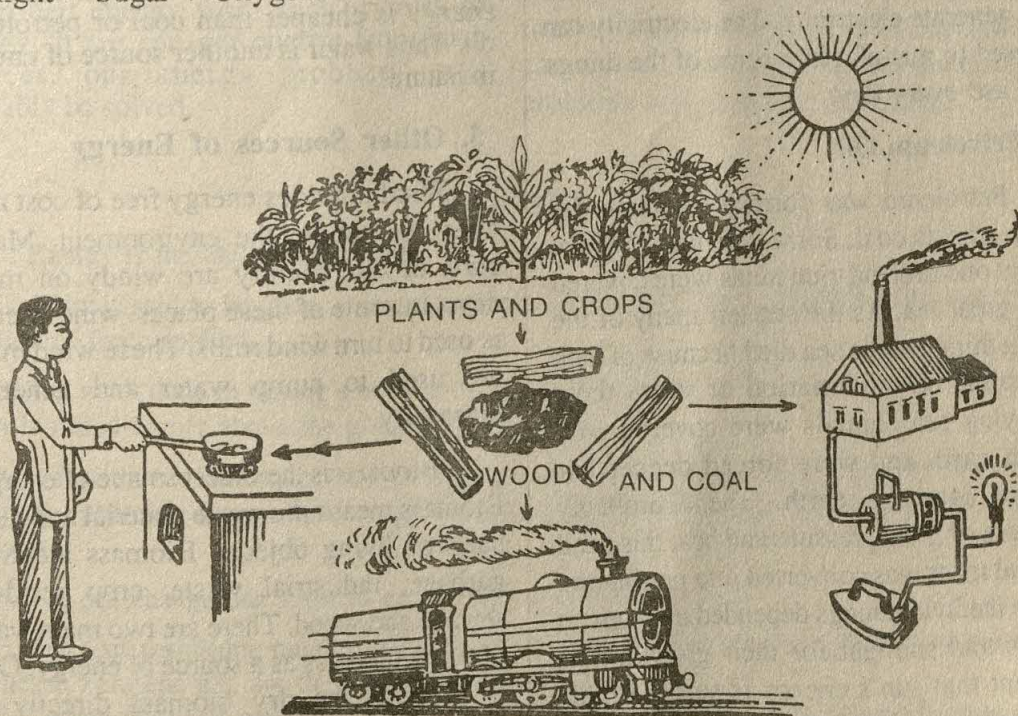


Fig. 11.7 Energy sources in Nature

solar cookers and solar heaters which make use of sun's energy or *solar energy*. *Solar battery* produces an electric current with the help of sun's energy.

2. Coal

Coal, which supplies the energy necessary to heat your homes and run big machines, was formed from green plants that grew millions of years ago. These plants needed the sun's light to grow and to make food. When the plants died, they decayed, changed to coal, and were buried beneath earth. Some of the stored energy of sunlight was also buried in the form of chemical energy in the coal. Man burns the coal to release the chemical energy it contains. This energy, for example, can be used to heat water to steam. The steam energy can be used to turn giant machines that generate electricity. The electricity can be used to manufacture some of the things you use every day.

3. Petroleum Oil

Petroleum was formed in much the same way as coal. Some scientists believe that at one time oil-rich lands were covered by a great sea. As the sea left many of the living things of the sea died because of lack of water. Over a period of years these decaying sea animals were covered with much earth and were forced deeper and deeper into the earth. Then, probably because of great pressure and heat this dead animal mass was converted into petroleum. Since the living things depended upon green plants and sunlight for their growth, it is evident that sun's energy is stored in this petroleum as chemical energy. And hence it is a source of energy in nature. Kerosene

and petrol are two commonly used fuels. They both come from petroleum. Wax and naphtha (a substance used in fertilizer industry) are also products of petroleum.

4. Water

The heat of the Sun evaporates many millions of kilograms of water each year from oceans and bodies of water (lakes, ponds etc.) at low level. The rain and snow from clouds are deposited on mountains and high elevations. Streams of water thus constantly, flow from high to low points on the earth's surface in rivers and streams. Power plants such as Bhakra Nangal Dam; Kesi Dam; Gandhi Sagar Dam; Hirakud Dam; Niagara Falls Dam use this running water to generate electricity. The running water coming from a height is used to turn the electric generators. Such *hydroelectric energy* is cheaper than coal or petroleum oil. Thus water is another source of energy in nature.

5. Other Sources of Energy

Wind provides energy free of cost and does not pollute the environment. Many parts of our country are windy on most days. In some of these places, wind energy is used to turn wind mills. These wind mills are used to pump water and generate electricity.

Biomass is the oldest source of energy. Biomass means the waste material and dead parts of living objects. Biomass includes garbage, industrial waste, crop residue, sewage and wood. There are two main ways of using biomass as a source of energy. One is to burn the dry biomass directly to produce heat and generate steam. Another method is to produce methane gas by the

decomposition (breaking down) of the biomass in the absence of oxygen. This gas can be used for cooking, lighting etc.

Water, wind, sun-light and biomass are called the renewable sources of energy, since they can be used again and again. Moreover, they are freely available and do not pollute the environment. Efforts are being made to use to the maximum of the energy available from them.

There are still many natural resources of energy that man has not yet been able to harness. For example, twice every day *huge tides* strike the shores of our ocean. The total energy of the tides is tremendously large. Energy released by *moving winds, cyclones* and *earthquakes* is also very large. Unfortunately we have not yet found the methods of getting controlled energy from such sources of energy. If we can get energy from such sources, our energy problems will probably be solved.

11.6 Energy Problems

Man's requirements of energy have been continuously increasing. In this 20th century, they have been increasing at a very rapid rate. To meet these requirements, man has looked for new sources of energy. He discovered steam and petrol engines and produced a variety of goods which have made the life of a large number of people around the world easier and comfortable. We must realize that the amount of natural fuels on the earth is limited. We do not have enough energy in our country today to meet all our needs. Therefore, we must use the energy we produce with care and economy. We should save electricity and kerosene. We should use buses and trains more than cars and scooters. We should use *gobar gas* which is easily and inexpensively made from cowdung. Scientists must be encouraged to find methods of harnessing energy from natural sources like high tides, cyclones, earthquakes, wind etc. That way our energy problems will probably be solved.

SUMMARY

1. Energy is the ability to do work.
2. *Work* is said to be done when on applying force a body moves through a distance in the direction of force applied.
3. The work done in raising a body is stored in the body in the form of energy. Thus a body which is raised higher above the ground has greater energy.
4. We have various forms of energy: Mechanical energy (kinetic energy and potential energy); heat energy; chemical energy, light energy, sound energy; electrical energy. Magnetic energy, atomic energy etc.
5. We can change one form of energy into another form.
6. Sun; coal, petroleum; running water, high tides; wind, sunlight; cyclones, earth-quakes; natural gas; diesel; kerosene etc. are the energy sources in nature.
7. Certain materials have the property of combining rapidly with oxygen and releasing a lot of heat in the process. Such materials are called fuels. The fuels we burn commonly are kerosene,

wood, coal, cowdung etc.

8. Sun is the main source of energy. Fuels are stored form of solar energy. Wind, sunlight, flowing water and biomass are renewable sources of energy.

9. Our body is constantly changing energy from one form to another. Our body needs fuel which is supplied in the form of food.

10. All over the world the energy stocks of stored energy in coal, oil, wood etc., are being used up in running factories, driving cars; lighting houses etc. It has, therefore, become an urgent problem in the world how to spend energy with care and economy so that it may last for a long period to come.

11. A body possessing greater energy is capable of doing greater work.

QUESTIONS

1. (a) What is energy?
(b) Are there different types of energy?
2. When we say, "We use energy" what do we really mean?
3. What are the sources of energy in nature?
4. Can we find new sources of energy?
5. How best can we make use of the energy available to us?
6. Write the various energy transformation that take place in the following:
 - (i) When an agarbatti is lighted in the dark.
 - (ii) When a moving ball strikes a glass pane.
 - (iii) A Diwali rocket is fired from the ground.
 - (iv) A cricket ball is thrown up, it returns to the ground and stops.
 - (v) A swinging pendulum.
 - (vi) Lights in the car are switched on when the car is not running.
 - (vii) A magnet lifts a nail from the table.
 - (viii) Wind a toy car and allow it to run on an inclined table, moving slightly upwards.
 - (ix) Rub both your hands against each other and you feel warm.
7. (a) Make a list of all the sources of energy which are used in your locality.
(b) Do you think that all forms of energy are related?
8. Distinguish between kinetic energy and potential energy. Give two examples of each.
9. What is transformation of energy? Give two examples to explain your answer.
10. Complete the following statements:
 - (1) A coiled snake, ready to spring at its prey is an example of

- (2) An arrow let loose from a bow has energy.
- (3) Kinetic energy is due to.....
- (4) Potential energy is due to
- (5) Energy and doing work are to each other.
- (6) is always required for doing work for exerting a force.
- (7) It is the energy hidden in the chemicals of the match head that gives us and when the match is struck.
- (8) We obtain..... energy from the food we eat.
- (9) In India, we have plants in Tarapore and in Trombay (Bombay) and these plants convert into
- (10) The sun and the stars convert into and that we get from them.

11. In each of the following items, encircle the number preceding the word or phrase that best completes the statement:

- (i) A compressed spring represents:
 - (a) kinetic energy,
 - (b) work,
 - (c) potential energy,
 - (d) a part of kinetic and a part of potential energy.
- (ii) Water in a dam leading to a waterfall possesses:
 - (a) potential energy,
 - (b) kinetic energy,
 - (c) neither P.E. nor K.E.,
 - (d) partly K.E. and partly P.E.
- (iii) When a simple pendulum vibrates, then at the mean position:
 - (a) its total energy is potential.
 - (b) its total energy is kinetic.
 - (c) it has both potential and kinetic energy.
 - (d) it has neither potential nor kinetic energy.
- (iv) A labourer raises bricks to the top of a building:
 - (1) by going up a vertical spiral stair-case.
 - (2) by going up a slanting ladder.
 Then,
 - (a) he uses more energy in the first case.
 - (b) he uses more energy in the second case.
 - (c) he uses the same amount of energy in both the cases.
 - (d) he does not use energy in either case.
- (v) Whenever Rajdhani Express approaches a railway station, its speed slows down: Thus its kinetic energy (a) increases, (b) decreases, (c) does not change at all.

12. State two examples in which no mechanical work is done on a body when a force acts on it.

13. State the factors on which the mechanical work done depends.

14. Write 'T' against those statements which are true and 'F' against those which are false:

- (i) Whenever a force is applied on a body, mechanical work is done on it.
- (ii) Work done is independent of the magnitude of force.
- (iii) If a body is lifted above the ground, its energy increases.
- (iv) A body possessing energy is capable of doing work.

15. State the relationship between work and energy.

16. Name the source of energy in a hydel power-station and a thermal power-station. Why are hydel power-stations preferred to thermal power-stations?

17. What is meant by renewable sources of energy? Name three renewable sources of energy.

18. Why should you prefer renewable sources of energy to non-renewable sources?

19. Name two devices which work on the solar energy.

20. Name three sources of chemical energy.

21. Name the sources of energy for the wind mill and an electric fan.

22. Why is coal called a fossil fuel? Name two more fossil fuels.

23. Name at least two devices which work with electric energy.

24. Explain how the energy from the sun gets stored in wheat?

25. In a cracker, which kind of energy is

- (i) stored in a cracker.
- (ii) required to ignite the cracker.
- (iii) given out when the cracker explodes.

26. Fill in the blanks:

- (i) The torch cell is source of energy.
- (ii) Cooking gas is a fuel.
- (iii) Wind is a source of energy.
- (iv) In hydel power stations the energy of is used.

27. A boy tries to push a truck parked on the roadside. The truck does not move at all. Another boy moves a bicycle through a small distance. In which case was the mechanical work done more—on the truck or on the bicycle? Give a reason to support your answer.

28. To get salt, the seawater is collected in shallow salt pans on the sea shore. The water evaporates and salt is left behind. Which energy brings about this change? What is the source of this energy?

CHAPTER XII

BALANCE IN NATURE

It is not possible for any organism to live alone. This world of ours is populated with so many different forms of life, and they are so widely spread in their distribution, that any one organism is dependent on so many others during its life time.

If we make a keen observation in our house, we see that we are :

- (i) Dependent on some animals.
- (ii) Some animals are dependent on us.

(iii) We are dependent on plants directly or indirectly.

(iv) There are some organisms useful to us and some causing harm to us.

Activity

1. Make a list of animals causing harm to you.

2. Make a list of plants which are useful to you.

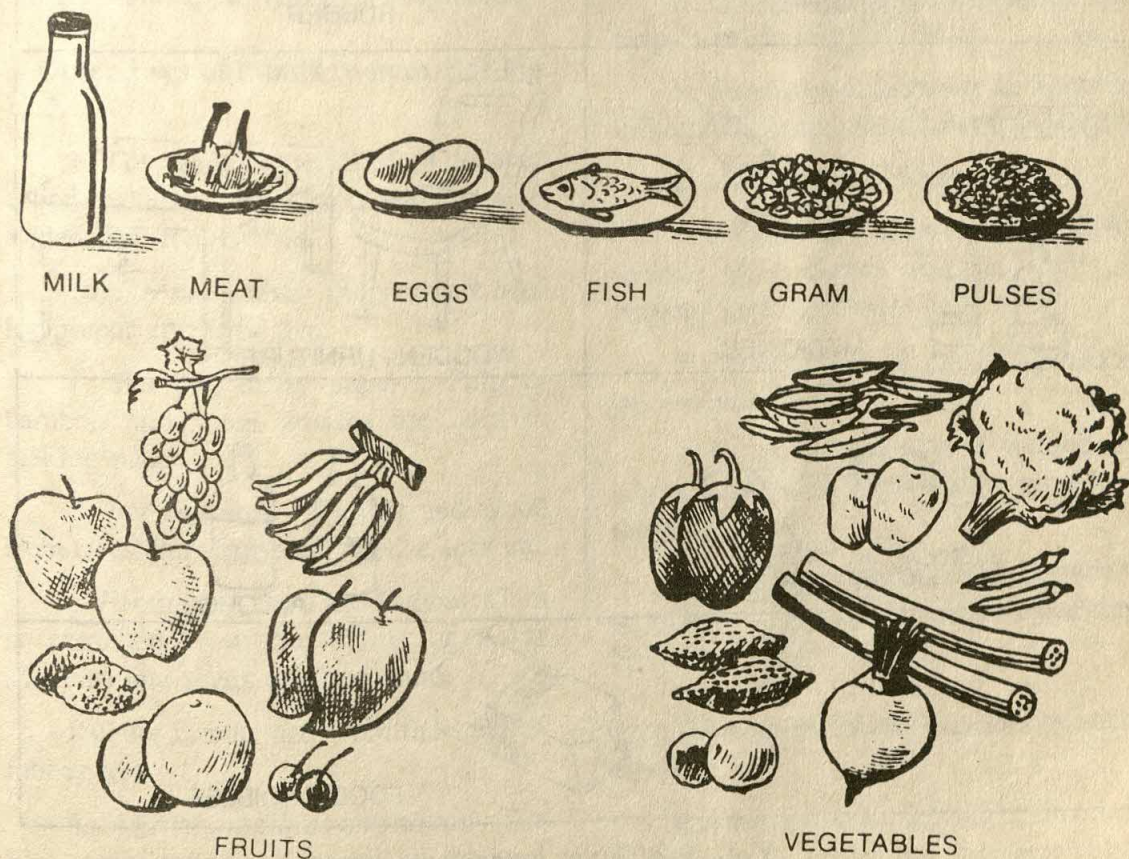


Fig. 12.1 Different Food Products

You have seen in a previous chapter that each living organism has a specific life span and animals continue to maintain their race. No organism is immortal. Ask your teacher to tell you an example of an immortal organism.

12.1. Why do organisms depend upon other species?

The question arises in your mind how and why we are dependent on each other

i.e., how it is difficult rather impossible to live alone.

If you study your daily routine carefully you will find out.

1. Your food comprises of

(i) *Animals*, if you are non-vegetarian—like fish, meat from goat, sheep etc.

(ii) *Animal products*: Like milk from cows, buffaloes, curd from milk, butter and

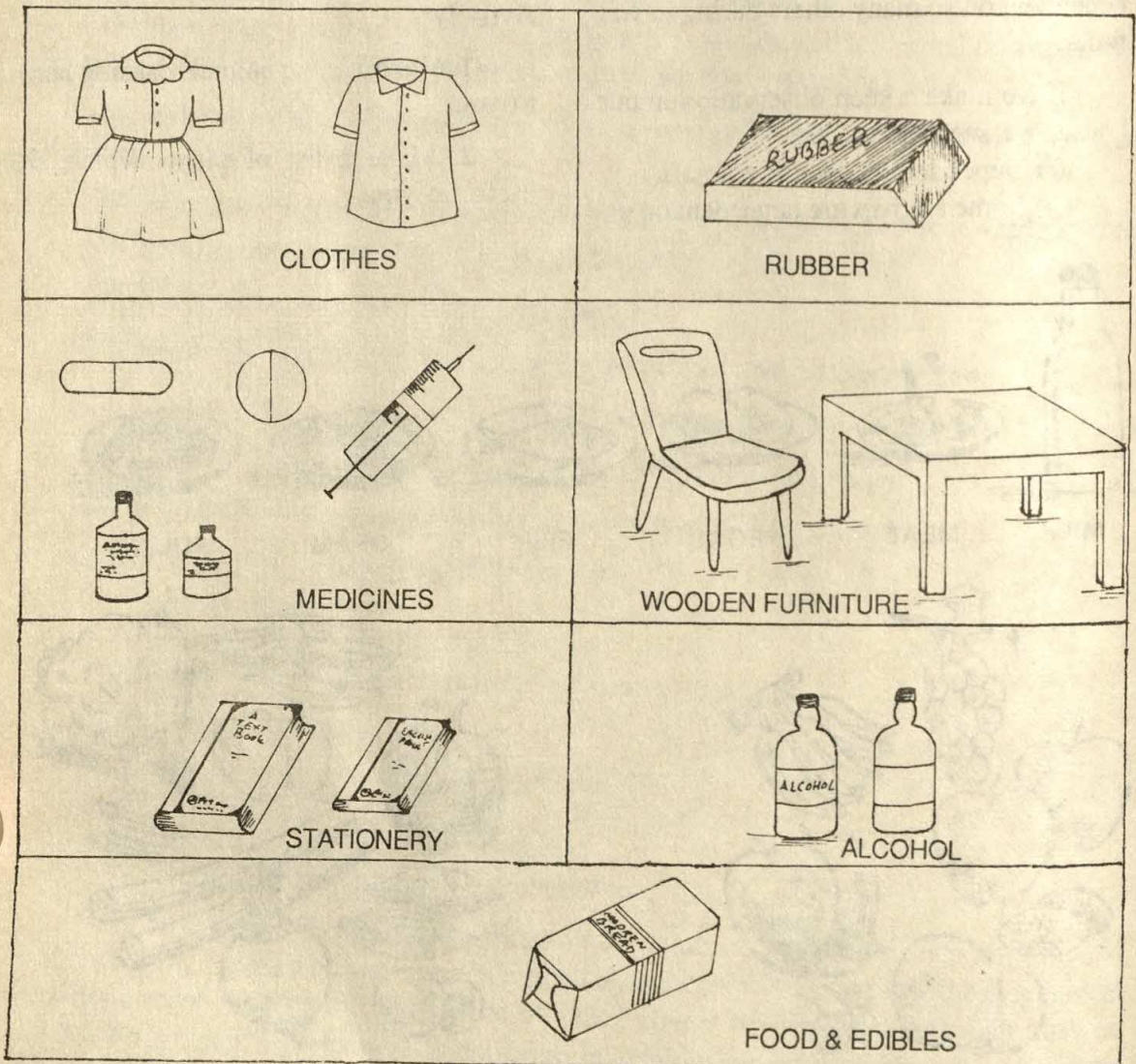


Fig. 12.2 Things made from Plants

ghee etc.

(iii) *Plant products* : Fruits, vegetables, rice, wheat flour, maize flour etc. (Fig. 12.1).

So we see that it is impossible for us to live without depending on other organisms with respect to our food.

2. Plants as direct source of oxygen

We talked in the last chapter, that green plants carry on photosynthesis. This is of course to synthesize food for themselves. Another very important function is that they absorb *carbon dioxide* and thus purify the atmosphere and release oxygen for our use and the use of other living organisms. This makes it possible for other organisms to carry on respiration.

3. Other Uses of Plants to man. See Fig. 12.2.

1. *For medicines*; (i) Bark of the plant called cinchona is used for making quinine, a medicine for malaria.

(ii) *Neem* : Leaves and stem are used for preparing medicines.

2. *For producing paper* : Pulp of bamboo and some grasses are used in making paper.

3. *For furniture* : Timber and wood from trees like sheesham, deodar, teak etc.

4. *For making Gum and Rubber* : Gum is extracted from the stems of Kikar (*Acacia*) and seeds of Guar plant.

Rubber is obtained from the stem of rubber tree.

5. *For making fibres and cotton* : The fibres from cotton and jute plants are used

for preparing threads.

6. *In the Industry* : (i) Bacteria is used in alcohol industry—for the preparation of alcohol, vinegar, citric acid.

(ii) Yeast is a plant used in the baking industry for baking bread, biscuits, cakes etc.

(iii) Bacteria is also used for making curd, cheese, vinegar etc.

4. Other uses of Animals to man

1. Birds help in the dispersal of seeds.

2. Birds help in carrying pollen grains from anther to the stigma of the flowers. This transference is called *pollination*.

3. Silk worms living on mulberry trees help in producing silk for us.

4. Fish helps in cleaning the water by killing insects and eating away the weeds.

5. Honey bees for honey.

6. Bones from animals are used for making jelly. Bones are also used for making some fertilizers.

7. Birds, dogs, cats, etc., are domestic pet animals of man.

8. Waste of the animal is used by plants as manure for the healthy growth of the plants.

It is seen that man is totally dependent on animals and plants. The dependence may be direct or indirect.

12.2. Dependence of other species on each other.

It is not only man depending on other organisms, the organisms also depend on

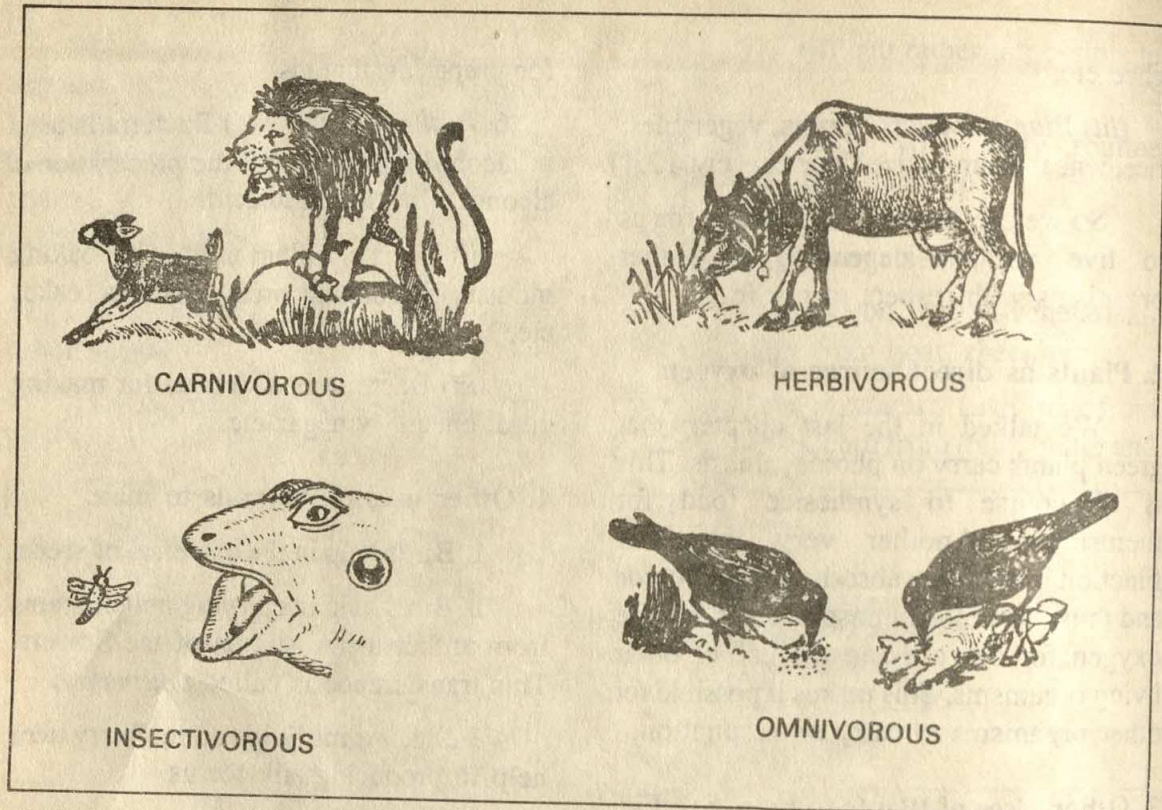


Fig. 12.3 Food Habits in Animals

each other. The dependence may be useful or harmful.

For example :

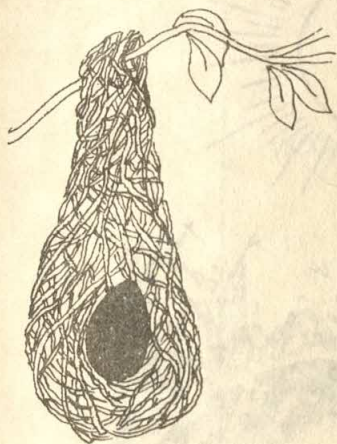
1. Carnivorous animals like lions etc., live on herbivorous animals like cows, deers, etc.
 2. Herbivorous animals live on plants.
 3. Insectivorous animals live on insects.
 4. Omnivorous animals live on plants and animals both, like human beings, dogs etc.
 5. Leeches and mosquitoes live on the blood of human beings and other animals.
- In this case leeches suck blood from

man and cause harm to the latter. The former is called a *host* and the latter is called a *parasite*. Think of more parasites in man's body.

There are some plants which are parasites on other plants.

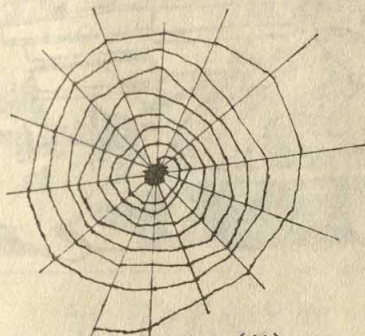
6. There are certain organisms which live in a close association and help each other in one way or the others, for example :

A *nitrogen fixing bacteria* (*Rhizobium*) lives in the roots of pulse plants. Bacteria fixes nitrogen for plants and in return takes shelter in the roots. This mutual helpful association is called *symbiosis*.

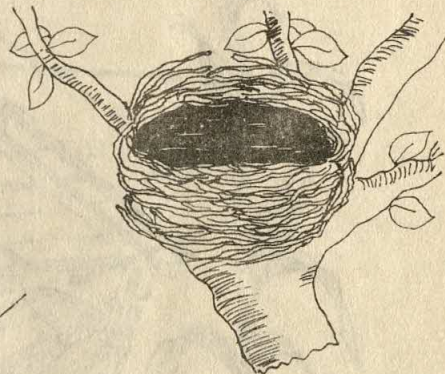


(i)

WEAVER
BIRD'S NEST



SPIDER'S WEB (ii)



(iii)

NEST OF A
COMMON BIRD

12.4 Dependence on plants for shelter

Dependence of Animals on Plants

Some animals like birds make their *nests* in tree trunks.

Birds use leaves, and dry straw for making nests (Fig. 12.4).

Plants provide a place for spider to form webs (Fig. 12.4).

Many insects live in the trees, like butterfly, firefly, beetle etc.

12.3 Food chains

If we revise whatever has been said above, we find that amongst living organisms there is a direct link. The main factor for maintaining a link is food. For example :

Grass is eaten by a herbivore, which

in turn is eaten by a carnivore, *i.e.*, there is existing a pathway of food consumption. This is called a *food chain*.

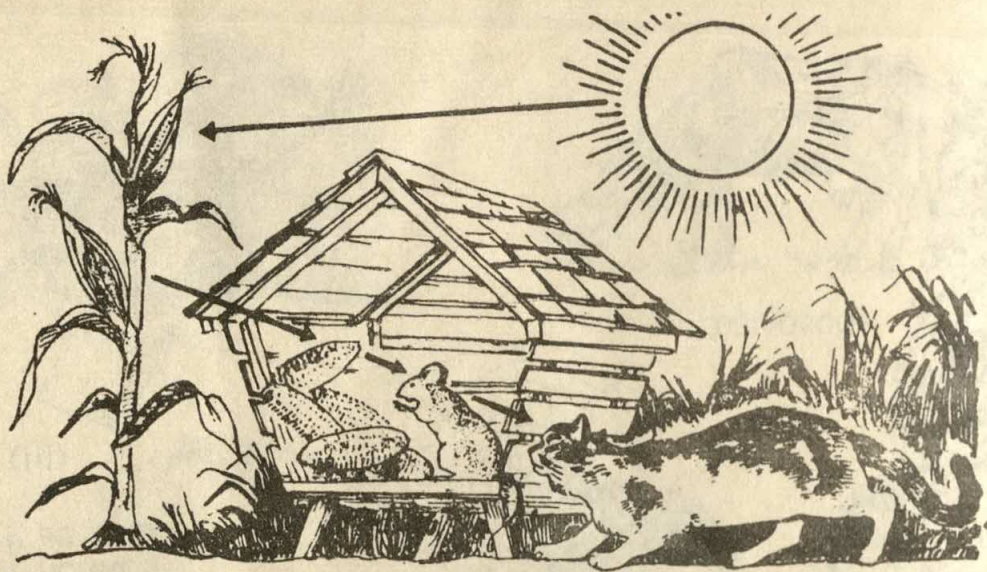
There are many food chains existing in the nature.

The feeding inter-relationships of any community are usually more complex than this. *For example*, on a school farm, in addition to the animals, you see, there are worms, field mice which feed on seeds and fruits, frogs feeding on insects, as well as snakes and lizards etc. The situation is described as a food web.

If you construct the food chain, it always begins with a *green plant*.

Green plant has the ability to capture energy from the sun and prepare food.

Green plants when are eaten by



12.5 A food chain

herbivores, the energy comes to these animals.

When carnivores eat the herbivores, the energy passes on to these organisms. Don't you see, the energy from the sun passes on to the plants and animals. This is called *Energy flow*.

Now we analyse that a food chain begins with a *producer* (a green plant), a primary consumer (a herbivore) and ends with a secondary consumer (a carnivore).

Organism in a food chain which is being eaten is a *prey* and which eats is a *predator*.

Keeping any food chain in mind you will see that there should be enough of green plants to continue the chain, there should be herbivores and carnivores respectively. If any step of the chain is broken the food chain is broken and if the

food chain breaks, you know what happens? Disturbance in nature is the ultimate result.

12.4 What happens to animals after death ?

Animals and plants after death rot and are eaten away by bacteria and fungi. This is called *decomposition*. Bacteria and fungi which help in decomposition of dead organisms are called *decomposers*. After that, dead organisms become a part of the soil. These bacteria and fungi act as scavengers, as they clean the earth of dead and rotting organisms.

Living organisms not only depend upon other organisms but their population depends on environment also, that is rain, temperature, soil, water and sunlight etc.

12.5. Balance to be maintained in Nature

You have learnt, if a food chain breaks,

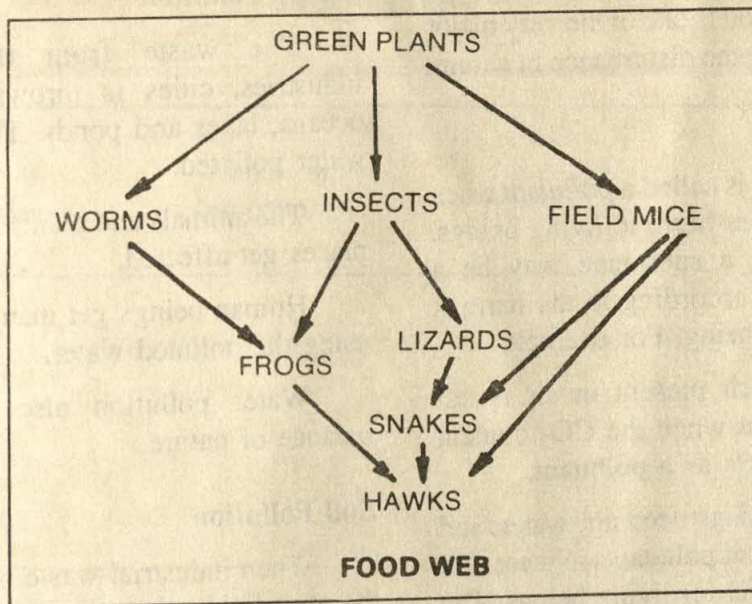


Fig. 12.6 Food Web

disturbance in nature is caused. It is, therefore, essential never to disturb the nature.

How can we not disturb the nature? Never kill any organism either for hunting or otherwise. Otherwise you are disturbing some food chain.

When the food chain is disturbed the balance of the nature is disturbed.

Let us learn, how do human beings disturb the balance in nature. The civilized man, with his technology and agriculture, disturbs the balance of nature :

(a) Trees are cut down in forest for making :

- (i) Enough place for agriculture to grow more to feed growing population.
- (ii) Enough place for building houses for *increasing population*.
- (iii) Wood available for the needs of growing population.

Harms of destroying trees

1. If forest are cut, the animals living in forests get disturbed, may get killed. This disturbs the food chain.

2. The soil becomes loose, by cutting the trees. The rain can wash away the soil on which crops could be grown.

3. The forest destruction reduces the rain fall. There will be *drought*, which can lead to land becoming *waste land* or desert. Don't you think, if this all happens, the nature gets disturbed. Forest destruction should be stopped completely.

(b) Do you know, everyday we use chemicals to kill mosquitoes, insects, etc.

If we kill insects or animals we disturb nature.

The chemicals like DDT, BHC etc. are very harmful to all of us, even our cattle and pets.

It must be kept in mind, that the growing population is one of the very major factor for causing the disturbance in nature.

12.6. Pollution

A substance is called a *pollutant* when its presence causes harm to living beings. This means that a substance may be a pollutant or not, according to the harm it causes to living being. For example :

CO₂ as much present in air is not harmful to us, but when the CO₂ content is increased, it acts as a pollutant.

All living beings need air, water and soil. The presence of pollutants in these will make them harmful for living beings. The process by which pollutants get added into air, water, a soil is *Pollution*.

Air Pollution

The smoke from the factories, burning of the oil, motor cars, burning of coal causes *air pollution*. Air pollution can cause *lung diseases*. You know that air directly enters into our lungs.

Water Pollution

The waste from the factories, industries, cities is thrown into rivers, oceans, lakes and ponds. This makes the water polluted.

The animals and plants living in these places get affected.

Human beings get many diseases by using the polluted water.

Water pollution also disturbs the balance of nature.

Soil Pollution

When industrial waste is thrown into the open fields, the soil gets polluted. The soil pollution effects the growth of plants and animals living in soil.

Noise Pollution

Land noise is bad for ears. It can cause deafness and mental imbalance in human beings.

Pollution needs to be checked, as it also causes disturbance of nature.

SUMMARY

1. All living organisms depend on each other to maintain the balance in nature.
 - (a) Human being are dependent on plants and other animals, for various reasons.
 - (b) Plants depend on animals.
 - (c) Animals depend on plants.
2. *Food chains, food webs*, form a very strong link between animals and plants.
3. Human beings disturb the balance of nature.
4. We must prevent pollution, to maintain balance in nature.

EXERCISES

1. Fill up the table :

<i>Names of Carnivores</i>	<i>Names of Insectivores</i>	<i>Names of Herbivores</i>	<i>Names of Omnivores</i>
1			
2			
3			
4			
5			

2. Make two different kinds of food chains.

1.

2.

3. How are the following useful to men :

(a) *Insects*

(b) *Plants*

(c) *Birds*

4. What happens—

(i) If food chain is broken ?

(ii) If pollutants are present in Air ?

(iii) If bacteria and fungi rot the dead animals and plants ?

(iv) If the forests are cut ?

5. What are :

(a) Predators

(b) Prey

(c) Producers

(d) Decomposers

6. Write a note on 'how does water get polluted where you live' ?

ACTIVITIES

1. Make charts for your class :

(a) On Balance in Nature,

(b) Harmful Animals.

(c) Food Web.

(d) Air Pollution.

(e) Water Pollution.

2. Construct the food chains for man.

3. Find out the names of five animals harmful to crops of man.

4. Find out the names of five plants harmful to human beings.

5. Construct a food web other than the one given in the book.

CHAPTER XIII

THE UNIVERSE

13.1. Introduction



Fig. 13.1 Night sky

To see the sky at night in all its beauty you must choose a clear dark night. You should also get away from towns into the open where there are no street lights and atmospheric pollution to swamp the faint star light.

By the very act of looking at the sky we become involved with astronomy. There can be few people who have not gazed at some time at the stars, and pondered just a little on mysteries of the universe and man's place in it.

Our ancestors saw patterns in the sky and made very careful observations of the motions of heavenly bodies. They made

careful records and discovered certain relationships which enabled them to predict some eclipses and other astronomical events much before people in the west learnt to do that. The regular behaviour of the Sun's rising and setting, the Moon's phases, and the positions of the Sun and the stars at different seasons gave them the means of regulating their lives.

Indian climate is moderate throughout the year and there are large number of clear nights in a year. Thus in India night watching can be fascinating. The history of astronomy abounds in valuable contributions made by amateurs, and even today, when professional astronomers work with expensive and highly sophisticated equipment, there is still a place for the amateur observer with his small telescope. It is possible to derive tremendous satisfaction from astronomy without any equipment but the naked eye. A good knowledge of the sky is a thoroughly pleasing thing. The sight of the stars and planets shining against the background of the Milky Way in a clear sky is still perhaps the most moving experience in the whole of astronomy.

13.2. What is Universe ?

A glance* at the sky on a clear, dark,

*Before glancing at the sky the observer must sit in a relaxed position without looking at bright lights so that his eyes may get accustomed to seeing in darkness. The observer may now stand up and watch the sky fixing any reference mark.

moonless night suggests that there are innumerable stars visible, but in fact the average number of stars that an ordinary observer can distinguish without a telescope on a good night is only about 3000 and the total number of stars in the entire sky which could be seen with the naked eye is between 5000 and 6000.

If the observer watches the sky for a sufficient time say more than an hour or he may watch it around the same time on different nights, he would notice that the stars change their respective position in the sky. They appear to revolve round the earth. They appear to revolve round the earth. They travel from east to west, rising in the east and setting in the west.

The position of the stars are measured on a coordinate system rather like latitude and longitude on the earth. It is convenient to imagine that the stars are points on a huge sphere called the *Celestial Sphere*, with the earth at the centre. This imaginary sphere appears to rotate round the earth from east

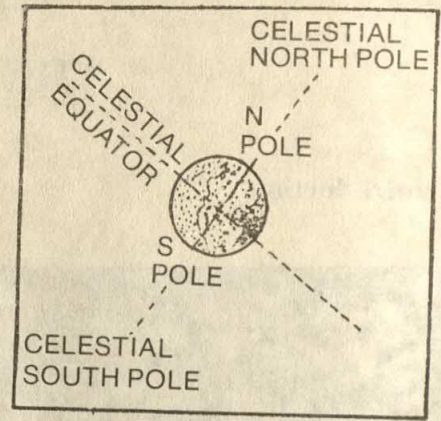


Fig 13.2. Celestial equator

to west. This apparent motion of stars is due to the rotation of the earth round its axis from west to east. To us the earth appears stationary and the various heavenly bodies in the sky like the sun, the moon and the stars appear to move in the opposite direction. Since the earth completes one rotation in 24 hours, to us it appears as if the Celestial Sphere (Fig. 13.3) completes

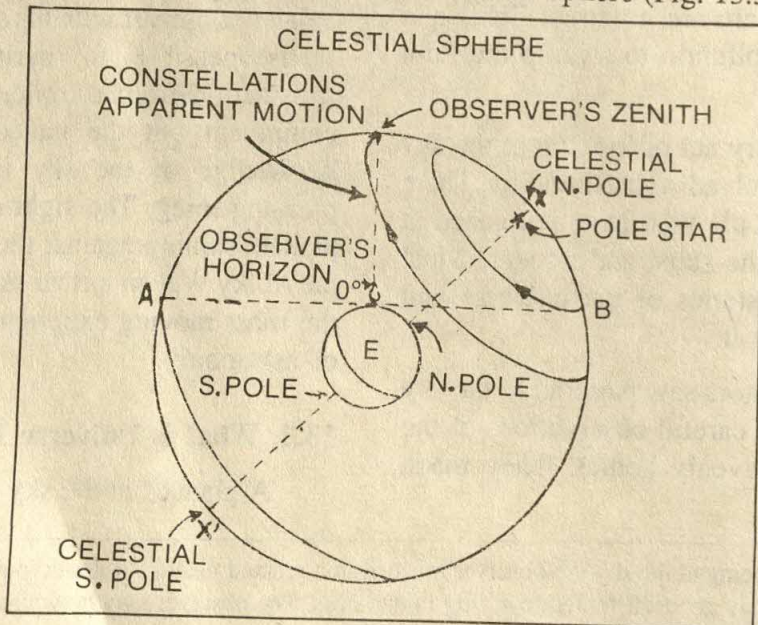


Fig. 13.3 Celestial sphere

one rotation in the same time. The axis of rotation of the Celestial Sphere is the same as the axis of rotation of the earth. By carefully watching the night sky towards the north, the observer can locate this.

As the earth revolves round the sun in its orbit, the direction of axis of rotation of the earth does not change and remains fixed in space throughout the year. But the earth's axis precesses, or wobbles, rather after the fashion of a spinning top, in such a way that the celestial north pole (that is, the point on the sky directly overhead at the earth's north pole (Fig. 13.2) describes a circle in the sky in a period of 26000 years. It is a pure coincidence that in the northern hemisphere, a particular star happens to lie very close to the celestial pole (that is the position where the axis of rotation of the earth cuts the celestial sphere). This star is known as the '*Pole Star*' of the '*Dhruva Tara*'. The word pole is derived from the Greek word '*Polos*' which means pivot. '*Dhruva*' also means unchanging or steadfast. As this star is the '*pivot*' of the axis of rotation, to us it appears fixed, unlike other stars. This is clear from Fig. (13.6) which is long-time exposure of the stars around the Pole Star. The camera was aimed at the Pole Star and the shutter left open for just two hours. The thick trail near the centre was left by the Pole Star. A brilliant meteor has also left its trail.

Some of the stars are bright, some are dim (Fig. 13.1). The stars are very large objects having the shape of a ball. They are much larger than our earth. Some of them are even bigger than the sun. They appear so small because they are very far away from us. You can see the stars only at night. The stars are present in the sky even in the day time. You cannot see them during the

day because of the bright light of the sun.

If you look at the stars carefully at night, you will find that they appear to be twinkling. You may also find some star like objects in the sky which do not appear to twinkle. In fact they are not stars. They are planets. The planets are the members of the family of our solar system. They revolve round the sun.

The sun is also a star. It looks much bigger and brighter because it is much nearer to us. The stars are very far away from one another. Even two nearest stars are many crores of kilometres apart.

Usually large distances are expressed in kilometres. Even this unit is not suitable to express distances between the stars and other heavenly bodies. They are millions of kilometres away from one another. The distances between them are therefore, expressed in the unit of *light years*. One *light year* is the distance travelled by light in one year. The speed of light is 300000 *km/s*. To know the distance light travels in one year, multiply 300000 by the number of seconds in one year.

∴ One light year

$$= 300000 \times 365 \times 24 \times 60 \times 60 \text{ km} \\ = 9460800000000 \text{ km.}$$

Can you imagine how large this distance is ?

The distance between the sun and the earth is about 15 crore kilometres. Light comes from the sun to the earth in about 8.3 minutes. Therefore, we can say that the sun is about 8.3 light minutes away from the earth. The next nearest star, Proxima Centauri, is about 4.3 light years away from the earth.

The brightest star Sirius is about 8.7 light years away from the earth. There are

some stars which are even millions of light years away from the earth.

Look at the sky at night when the moon is not there. You may see a huge strip of faintly glowing light from north to south across the sky. It is known as the *Milky Way* (Fig 13.4). It is made up of a cluster of countless stars. The sun is one of these stars. There are several other clusters of stars in the universe. They are called *galaxies*. Our Milky Way is one of the millions of galaxies which exist in the Universe. Some of the stars are so far away from us that their light has not yet reached the earth. What do you think lies beyond these super galaxies ?

All objects in the universe are in continuous motion. Our Milky Way with the sun and the stars is also moving (Fig 13.4). It is also revolving on its axis. Due to this, the sun moves at a speed of about 220 km/s .

13.3. Constellations

Even the casual observation of the night sky reveals that the relative positions of the different stars do not change at all. The stars appear to fall into well-defined patterns and groups or clusters. All the stars in a cluster or group move together in the sky and hence the pattern of the group or cluster does not change during their movement. *A group or cluster of stars in a limited region of the sky that forms a pattern is called a Constellation.*

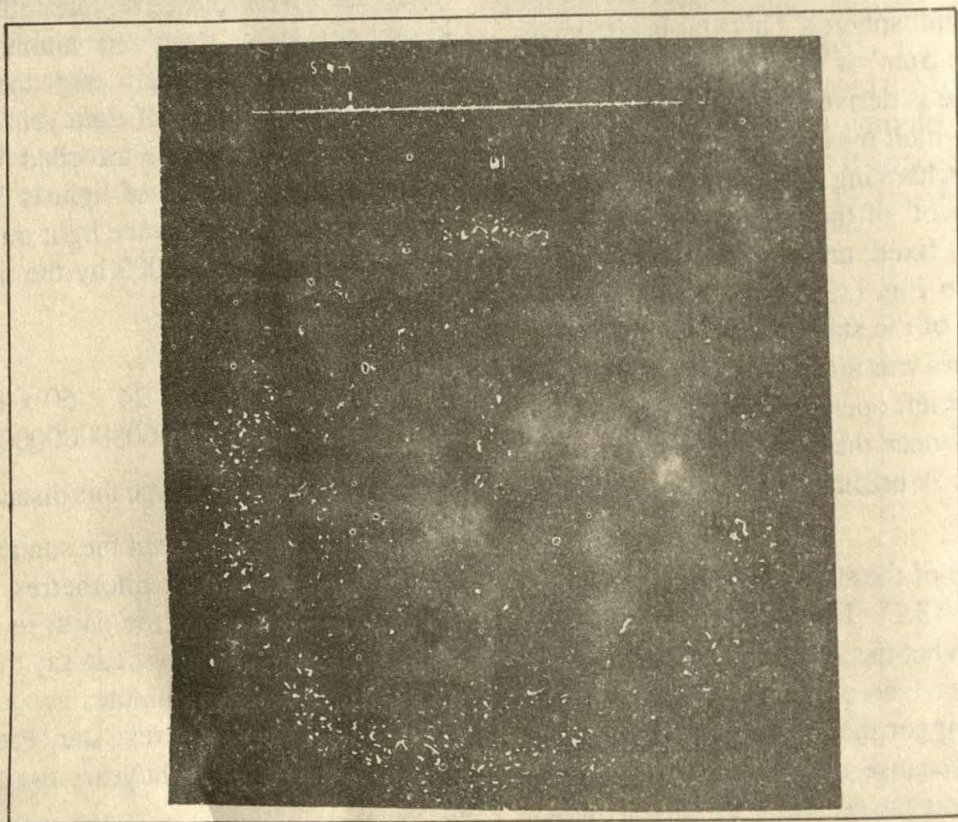
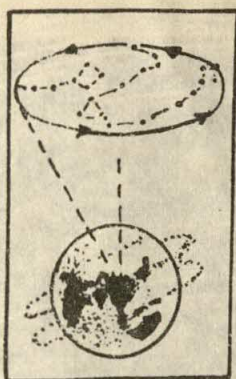


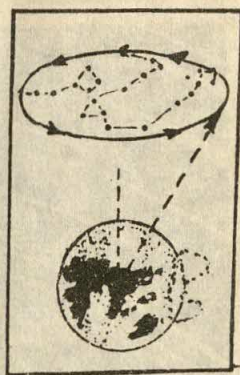
*Fig. 13.4 (a) The position of the Sun and the Milky Way
(b) The Galaxy or the Milky Way consists of millions of stars.*



(a)



(b)



(c)

Fig. 13.5 Celestial northpole describes a circle in a period of 26,000 years

For thousands of years men have divided the sky up into the constellations.

The ancients named the constellations after mythological characters, gods and demigods, as well as everyday objects and creatures. Though the forms of some of the groups are readily apparent, a fairly colourful imagination is needed to make out many of the others. The shape of one group of stars suggested a dragon (Draco); of another, a Great Bear (Saptarishi) which is a formation of seven stars, and similarly the shapes of other groups of stars suggested other familiar objects. A few of the prominent constellations are shown in Fig 13.7. Some of the north polar constellations are easy to learn, such as :

(1) **Ursa Major (Great Bear or 'Saptarishi')** is a key constellation readily recognizable by the seven brightest stars which form the plough or kite with a thread or Big Dipper. Four stars form the plough-share or kite and the other three the handle or the thread (Fig 13.8). A line through the stars 1 and 2 known as the 'pointers' leads to the Polar Star. During the spring and the

summer, it is above the horizon in the early part of the night.

(2) **Ursa Minor (Little Bear or 'Dhruva Matsya')**. The seven principal stars of this small and rather faint constellation form a shape similar to the Plough or a kite with a thread tied at one corner except that the tail curves in the opposite direction. The Pole Star lies at the end of the tail or the 'thread' [Figs. 13.5 (a) & (b) and 13.6] It is easily visible during autumn.

(3) **Draco (Dragon or 'Kaleya')**. A long faint constellation twisting around Ursa Minor, Draco depicts a dragon or 'Kaleya'. One of the stars in the tail of the Dragon was the Pole Star at the time of the building of the pyramids.

(4) **Cepheus**. This constellation is not too easy to identify and can best be recognized by thinking of it as a little house with a peaked roof.

(5) **Cassiopeia ('Sarmishtha')**. A very

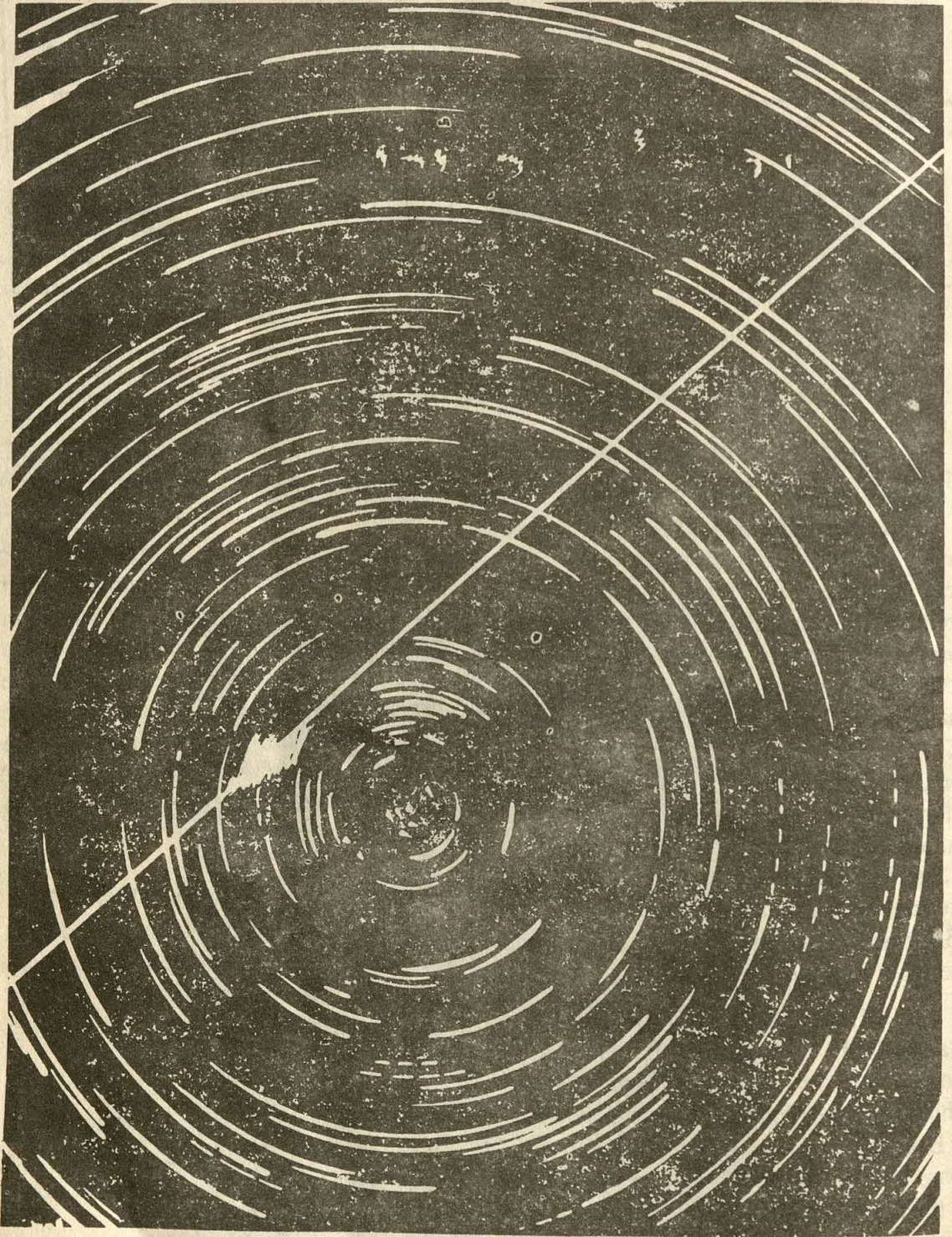


Fig. 13.6 Long-time exposure of the stars around the pole star

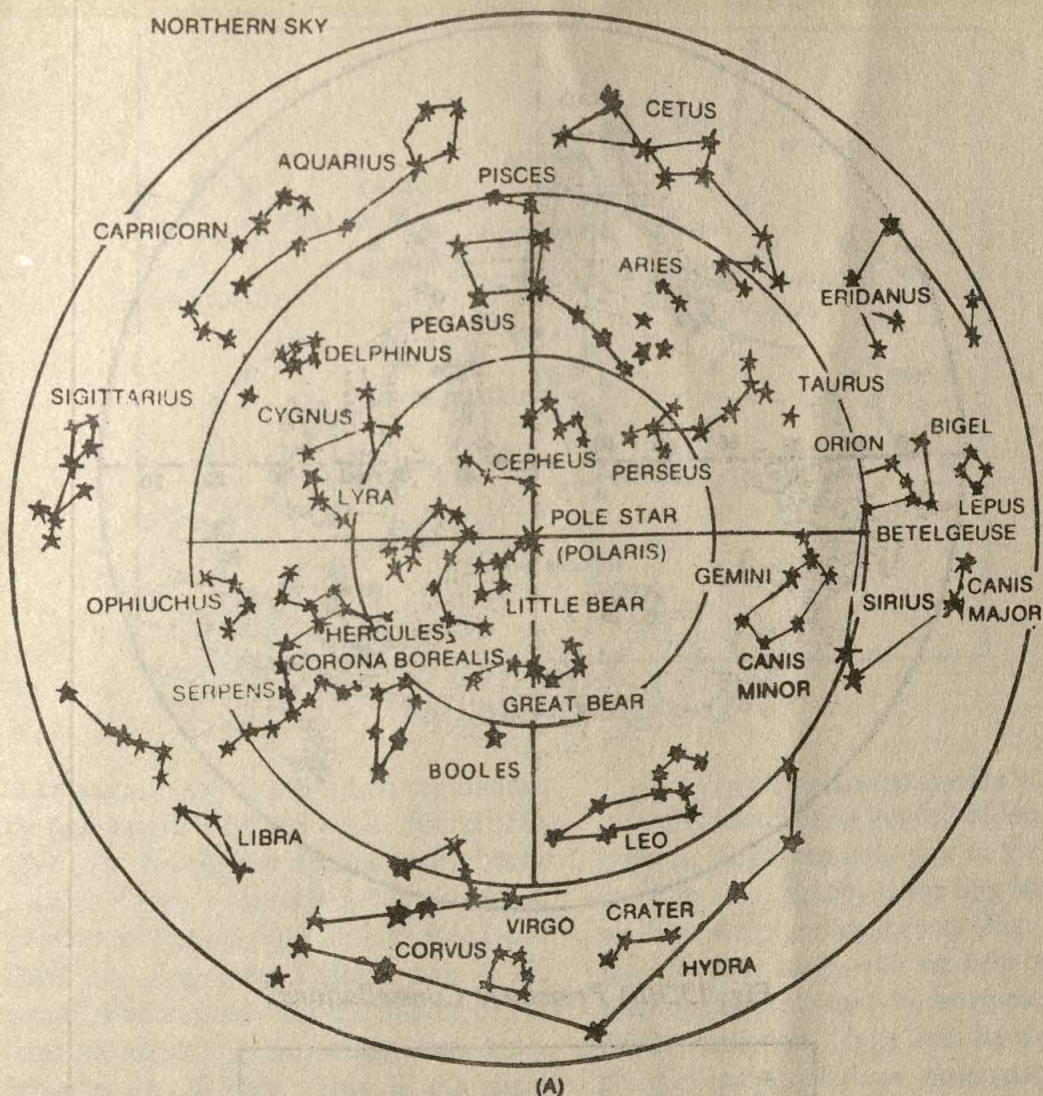


Fig. 13.7(a) Prominent Constellations

notable constellation shaped like a W, it depicts a queen seated on her throne. The Milky Way (the shaded region in [Fig. 13.7 (b)] runs through the constellation and the group presents a beautiful sight through binoculars. It is also easily visible during autumn.

(6) Auriga (Charioteer or

'Sarathi'). This, the charioteer or Sarathi, is a very conspicuous constellation and contains the yellow star Capella. Lying on the edge of the Milky Way, the group contains some fine clusters [Fig. 13.9 (a)].

(7) Orion. Orion is a bright constellation that is seen in the north in winter and in the south in summer. The

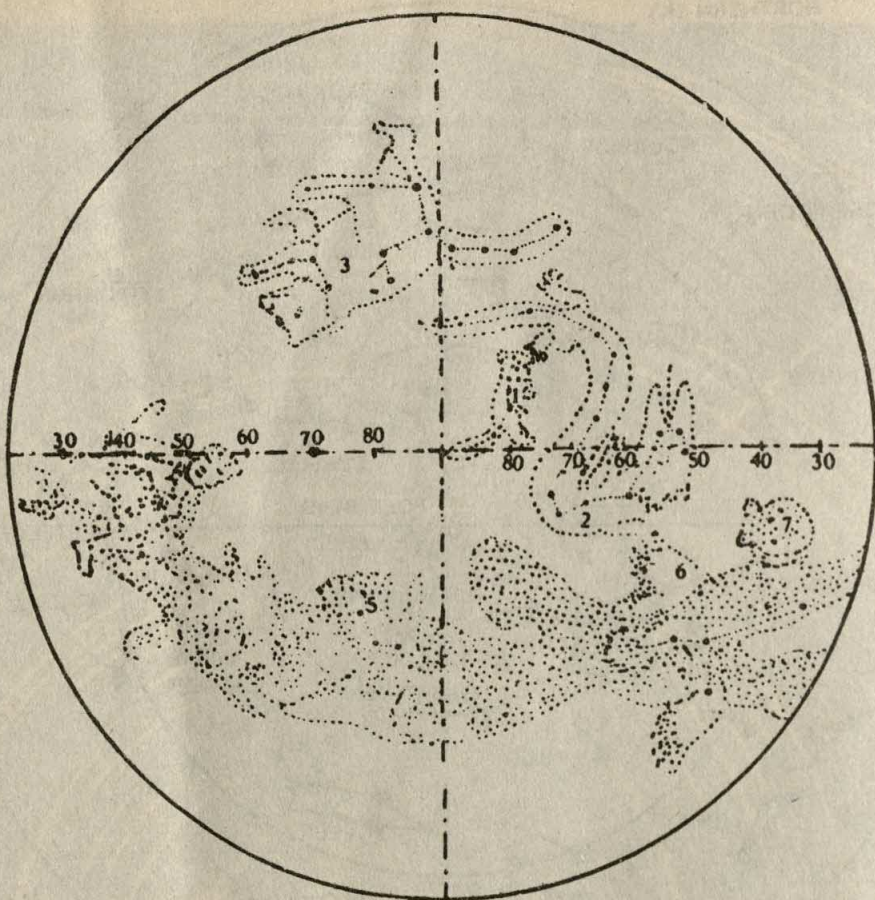


Fig. 13.7(b) Prominent Constellations

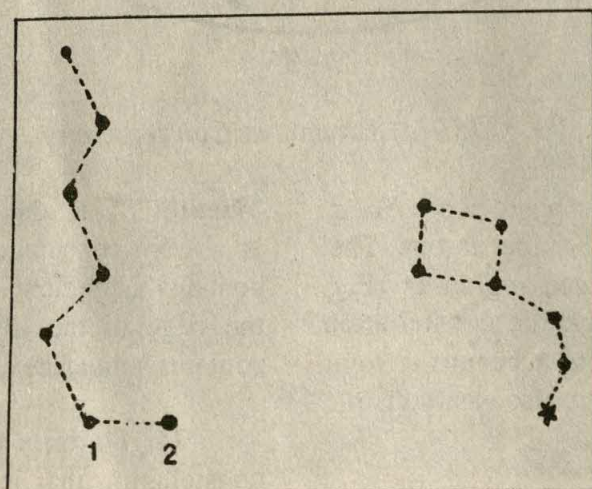


Fig. 13.8 Ursa Major and Ursa Minor

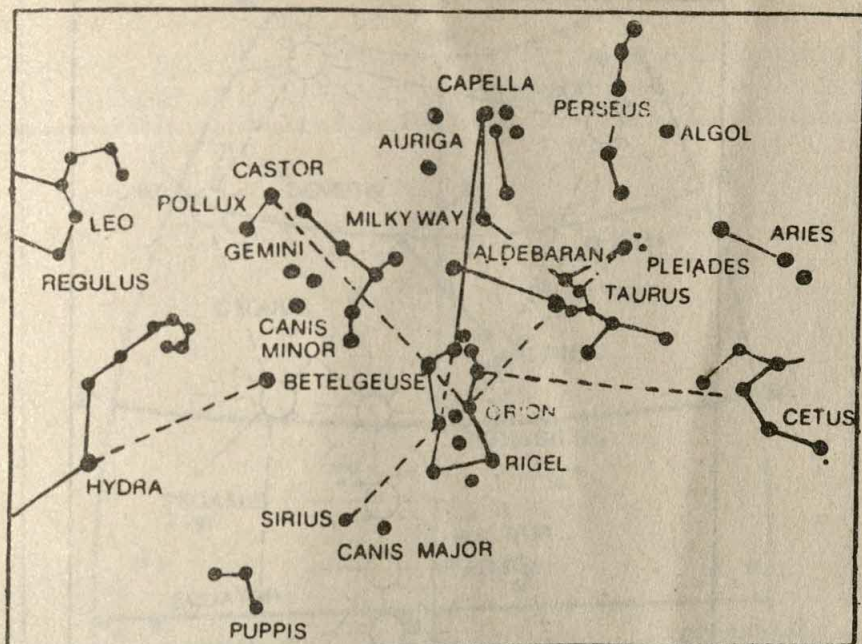


Fig. 13.9(a) Auriga and Orion

three stars in the Orion's belt surrounded by four bright stars are easily found [Fig. 13.9 (b)]. Betelgeuse (pronounced beetle juice) at the top left and Rigel (a blue white giant) at the bottom right are both Red Giant Stars. Hanging from Orion's belt is his sword. You can see that the middle of the three sword stars is not really a star but a fuzzy patch of light. This is the great *Nebula*, a cloud of dust and gas where new stars are born. The brightest star in the sky, "Sirius" lies close to this constellation (Fig. 13.8). Orion is also called *kalpurush*. It appears like a hunter.

(8) **Cygnus (Swan or 'Hansa').** Cygnus, the Swan or 'Hansa', is a beautiful constellation, often known as the Northern Cross because of its shape (Fig. 13.10). The brightest star, Deneb, lies in the head of the swan. The Milky Way runs through the constellation.

(9) **Lyra ('Svaraa-Mandala').** Lyra is a small constellation but full of interesting objects. Vega, the only star in the group, is white-blue. Nearby is the ring Nebula, a well-known planetary nebula (Fig. 13.10). Observations made with the help of space satellites indicate that the brightest star in this constellation, 'Vega' may have planets going round it. If these observations are confirmed, Vega will become the second star in the universe around which planets have been discovered. The first one being our Sun.

Most of the major present day constellations were named by the Greeks, although the Latinized forms of the names are normally employed. In fact Ptolemy catalogued 48 constellations to which others have added, there now being a total of 88.

Because of the rotation of the Earth, the whole celestial sphere appears to rotate

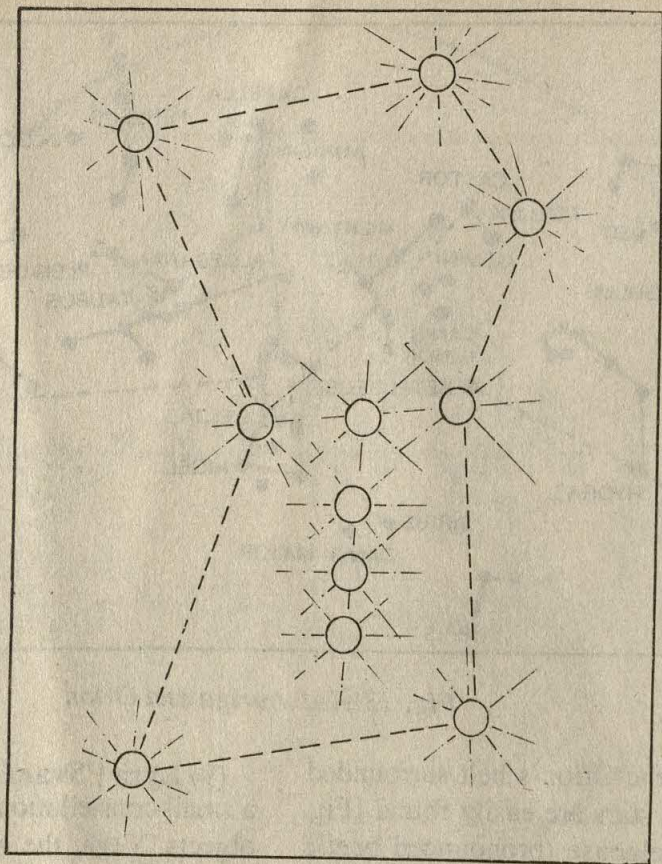


Fig. 13.9(b) Constellation Orion appearing like a hunter

once a day and so the constellations move across the sky. Furthermore, as the Earth moves round the sun in its orbit, different constellations become visible in the night sky. In fact the constellations seem to rise four minutes earlier each day until, after a full year, they have returned to their positions.

The easiest way to learn the constellations is to begin by finding two or three immediately recognizable constellations and to use these as signposts to the other conspicuous ones. The faint, ill-defined constellations can then be filled in with ease.

Figs. 13.9 and 13.10 are the stars maps of a part of the northern sections of our hemisphere. Fig. 13.11 gives another star map of the northern hemisphere showing several constellations which can be seen in the night sky during the year. The observer should try to identify the different constellations in this map and learn their relative positions.

13.4. Pole Star

It is a pure coincidence that in the northern hemisphere, a particular star happens to lie very close to the celestial north pole (that is the position where the

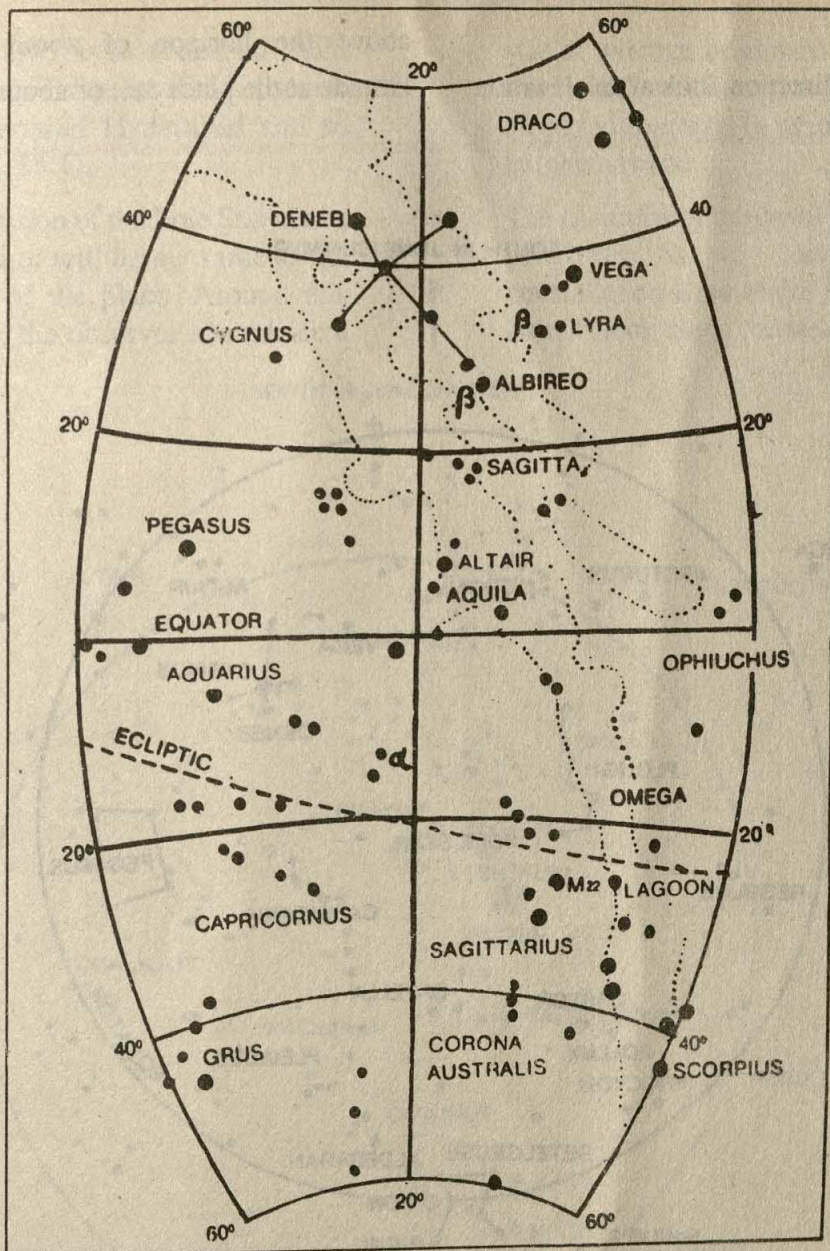


Fig. 13.10 Cygnus and Lyra

axis of rotation of the earth cuts the celestial sphere). This star is known as Pole Star or the "Dhruva Tara". The Pole Star is almost exactly over the North Pole of the earth, so it does not appear to move around the sky as the earth spins, like the other stars. So the Pole Star is a pointer to the north.

Identification of the Pole Star

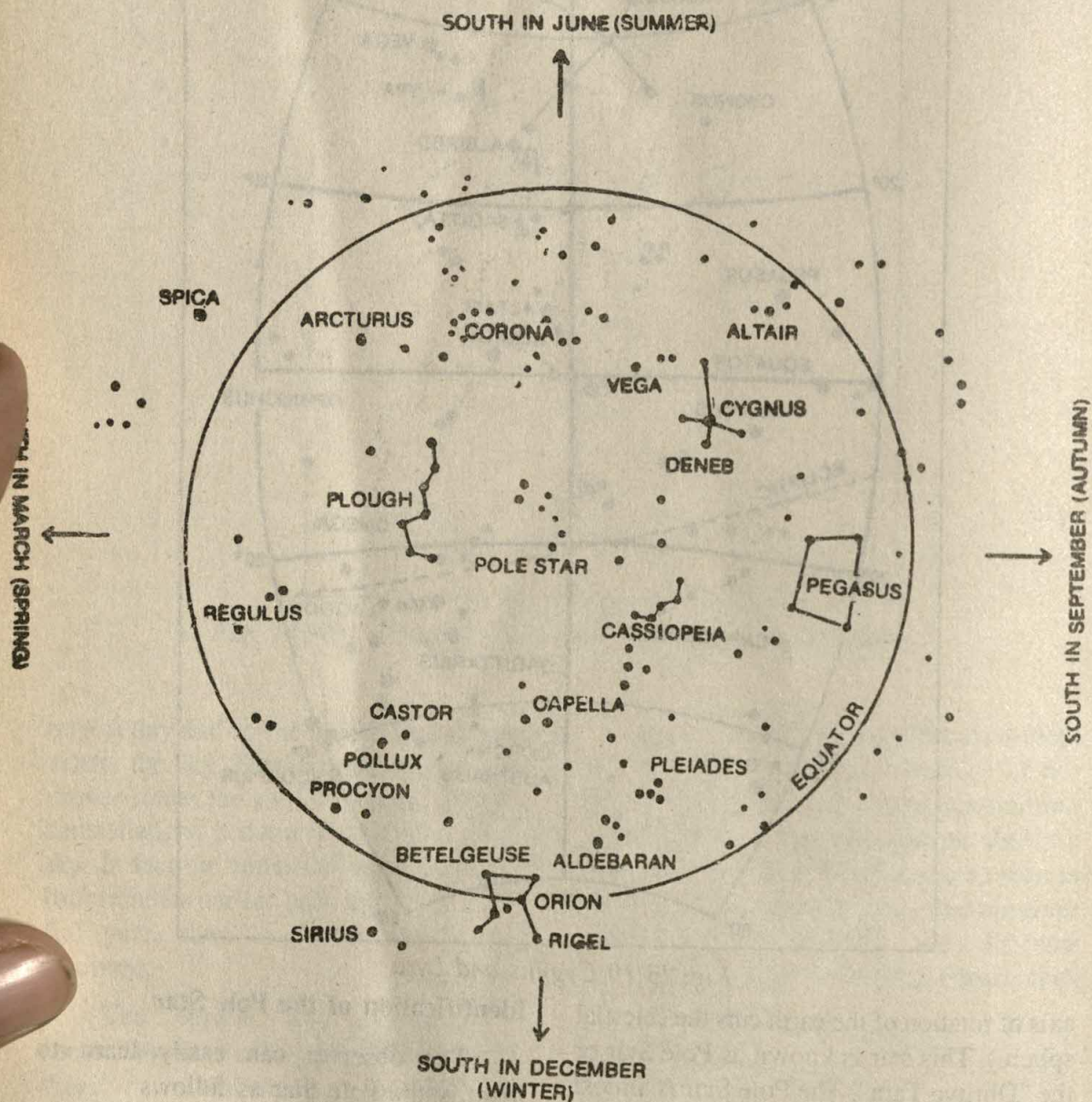
The observer can easily learn to identify the Pole Star as follows :

- (i) Locate the north with a magnetic compass or knowing the direction from which the sun rises, identify

the north.

(ii) In this direction, look at an elevation

above the horizon of about the latitude at the place *i.e.*, of about 30°



NORTHERN HEMISPHERE

Fig. 13.11

if the observer is in or around Delhi or of about 17 degrees if the observer is in or around Hyderabad and so on (Table 13.1).

(iii) The elevation of the Pole Star above the horizon will be the same as the latitude of the place. Around this position, the observer should see a

star of average brightness. This is the Pole Star. There are no other clearly visible stars in its immediate neighbourhood.

(iv) The easiest way to identify it more precisely is to locate the constellation Ursa Major (or Great Bear). Look along the seven bright

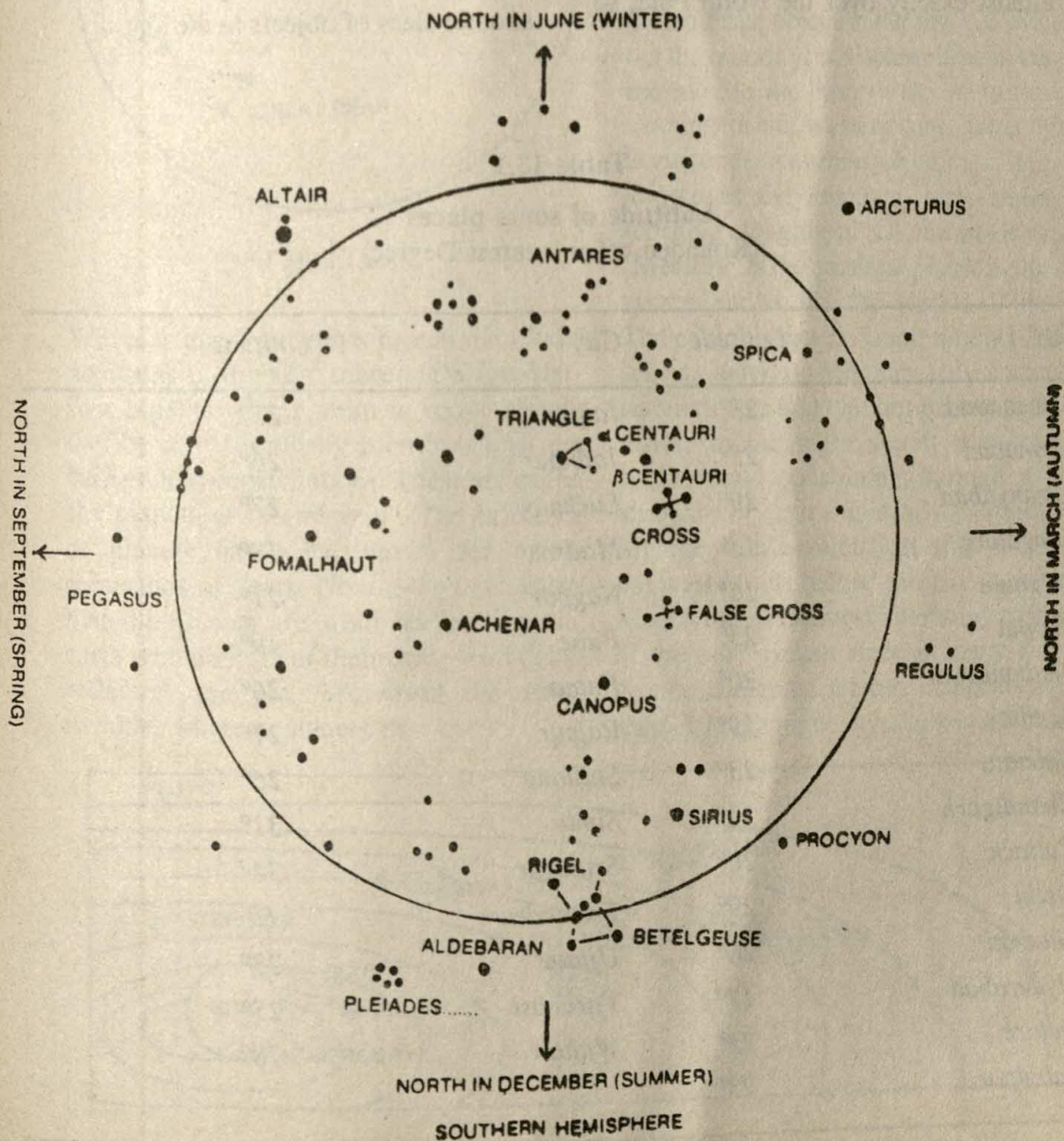


Fig. 13.12

stars that form a kite with a thread tied at one corner. The last two of these stars point directly to the Pole Star (Fig. 13.13).

Sailor's Star

At night sailors at sea can use the stars to navigate or find their way. The Pole Star is almost exactly over the North Pole, so

it does not appear to move around the sky like the other stars. So the Pole Star is a pointer to the north and its position in the sky can tell sailors how far north their ship is.

13.5. The Solar System

While classifying groups of stars into constellations, the early people noted another class of objects in the sky.

Table 13.1
Latitude of some places
(Rounded off to nearest Degree)

City	Latitude	City	Latitude
Ahmedabad	23°	Jaipur	27°
Allahabad	25°	Jodhpur	26°
Aurangabad	20°	Lucknow	27°
Bangalore	13°	Madras	13°
Belgaum	16°	Nagpur	21°
Bhopal	23°	Pune	19°
Bhubaneswar	20°	Patna	26°
Bombay	19°	Rajpur	21°
Calcutta	23°	Shillong	26°
Chandigarh	31°	Simla	31°
Cuttack	20°	Srinagar	34°
Delhi	29°	Trivandrum	8°
Gauhati	26°	Ujjain	23°
Hyderabad	17°	Varanasi	25°
Indore	23°	Waltair	18°
Jabalpur	23°		

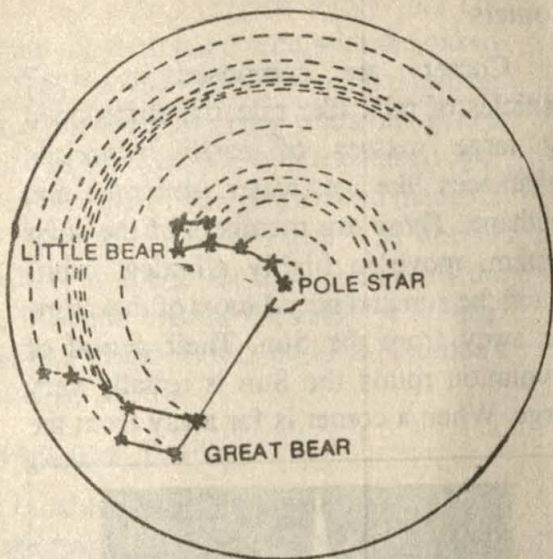


Fig. 13.13

Whereas the stars seem to maintain fixed positions in the sky, there are a few star-like objects which seem to move slowly day by day, month by month against the background constellations. These are called the planets or "wanderers". The existence of planets has been known for many thousands of years. Now-a-days we know that the planets are solid bodies like the earth with no light of their own, shining by reflected sunlight. Moreover the stars twinkle, whereas planets do not.

Our solar system has nine planets. They are : Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto.

The nine planets revolve around the Sun in the same direction and very nearly in the same plane.

Out of these nine planets, five are clearly visible to the naked eye. Venus is the brightest object in the night sky (leaving out the moon). It is visible either in the early morning in the eastern sky or in the early evening in the western sky. When Venus is visible at an evening elongation, it is often known as the *evening star*, whilst at a morning elongation, it is the *morning star*. 'Mercury' is the smallest planet in the solar system and is also the closest to the Sun. The early observers found it rather hard to see any detail on Mercury at all because of its small size and the fact that when it was visible in the night sky it was near the horizon and so shining through a large amount of our unsteady atmosphere. Mercury can be seen just after sun-set in the west or just before sun-rise in the east. Mars is one of the most interesting members of the solar system since in many ways it is quite similar to the earth. It appears a little *reddish* in the night sky. Jupiter and Saturn

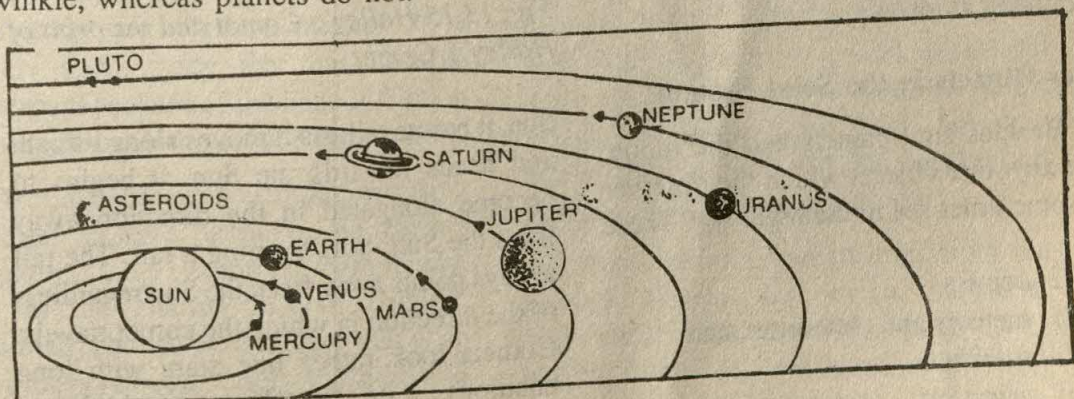


Fig. 13.14 Solar System

are the giants of the solar system. Jupiter is a truly enormous world, eleven times greater in diameter than the earth and its volume is quite sufficient to hold 1300 earths. Beyond Saturn lies the twilight zone of the solar system, where the sun appears much smaller and cooler than it does to us and where there lies the last three known members of the solar system, all of which were discovered telescopically. They are Uranus, Neptune and Pluto.

In Calcutta, Delhi and many other big cities in India, planetaria have been built. Here they pretend to have the motion of the stars and the planets on the inside of a large dome. Students must make it a point to visit a planetarium and get valuable information.

Maharaja Jai Singh of Jaipur got built five huge astronomical observatories in Delhi, Jaipur, Mathura, Ujjain and Varanasi. In those days, these were considered as very accurate. Now these are not much in use because of the greater accuracy obtainable with telescopes.

Newspapers and magazines publish the night sky maps and give the positions of the planets. *Science Reporter*, a monthly journal of the CSIR, New Delhi, gives this information in details.

Other Objects in the Solar System

Besides sun, planets and the moon, there are other objects which the observer can some times see in the night sky. These are:

- (i) comets
- (ii) meteors and meteorites, and
- (iii) satellites
- (iv) asteroids

Comets

Comets are composed of small particles of rock like material surrounded by large masses of easily vaporised substances like ice, water, ammonia and methane. These are members of the solar system, move in highly elliptical orbits round the sun and spend most of their time far away from the Sun. Their period of revolution round the Sun is usually very large. When a comet is far away from the

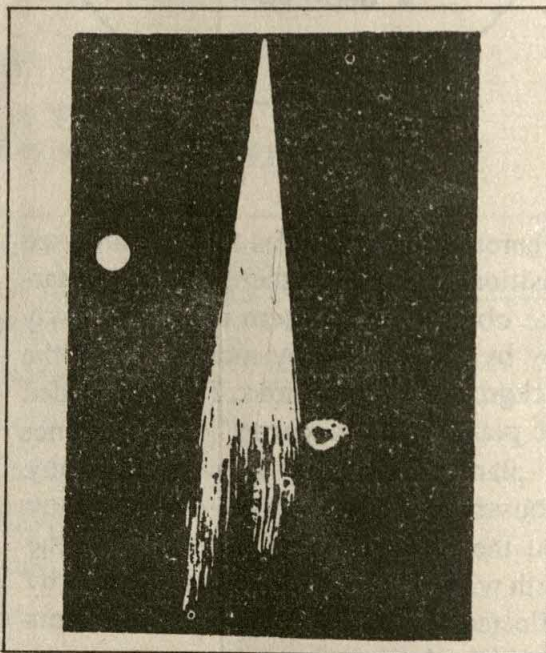


Fig. 13.15 Halley's Comet and the orbit of Halley's Comet

Sun, it has no tail. As it moves along its path and heads towards the Sun, it begins to become elongated in the direction away from the Sun, thus forming a tail. The tail always points away from the Sun regardless of the direction in which the comet travels. Comets look rather like stars with long nebulous tails stretching hundreds of millions of kilometres in the sky.

A few comets appear every year but they are too faint to be seen with the naked eye. They are visible only through powerful telescopes. Once in many years one gets a chance to see a comet with the naked eye. Halley's comet with a bright head made its last appearance in 1986 and it is due to reappear in 2062. As it is nearest to the Sun, it comes within the orbit of Venus, while at its farthest it is beyond Neptune's orbit (Fig. 13.15).

Meteors and Meteorites

In addition to the planets and comets that are revolving around the sun, millions of very small bodies sometimes called *planetesimals* and weighing few grams to hundreds of metric tonnes are likewise moving around the sun throughout the space occupied by the solar system. Occasionally the earth in its orbital motion comes so close to one of these bodies that the body is attracted towards the earth by the earth's large gravitational force. As the object comes hurtling toward the earth's surface, it moves through the extensive layer of gases that we call atmosphere. The friction of this motion produces heat that causes the outside of the small fast-moving body to become incandescent, and we see *meteor* or *shooting star*. Thus a meteor is a relatively small body that has become incandescent because of the heat of friction in passing through the earth's atmosphere.

Most meteors are so small that during their brief passage through the earth's atmosphere they vaporize completely. owing to the intense heat of friction. Occasionally, however, a meteor that is so large, it does not completely vaporize and actually reaches the earth's surface. It is then

called a *meteorite*. Thus meteorites are those objects which are quite large and sometimes may reach the ground. Meteorites are relatively rare, and since there is more sea than land on the earth, the majority may fall into the sea. However, some large ones have been found such as the Hoba West meteorite in South Africa.

The cause of craters on Moon, Mercury and Mars is due to meteorites.

Satellites

A heavenly body revolving round another is called a *satellite*. Till to-day 43 satellites are known. These satellites are called natural satellites. Some planets do not have any satellites whereas some have many. Scientists may discover some more satellites in the near future. The moon is the natural satellites of the earth. It completes its revolution around the earth in 27.3 days. Its distance from the earth is about 384400 km. An artificial object that circles another body is known as *artificial satellite*. The earth has many artificial ones. In recent years several artificial satellites have been launched in orbits, round the earth with the help of multistage rockets. The year 1957 saw the launching of the first-ever artificial satellite, Sputnik 1, by the Russians. The first manned space flights took place in 1961 with Yuri Gagarin for the Russians and Alan Shepard for the Americans. These first-flights were quite short, but now astronauts can stay up for weeks and perform complicated operations.

India has also put in orbit from the Soviet Union an earth satellite. "ARYABHATA" on 19th April, 1975 a named after the celebrated astronomer Aryabhata of the fifth century A.D. Other

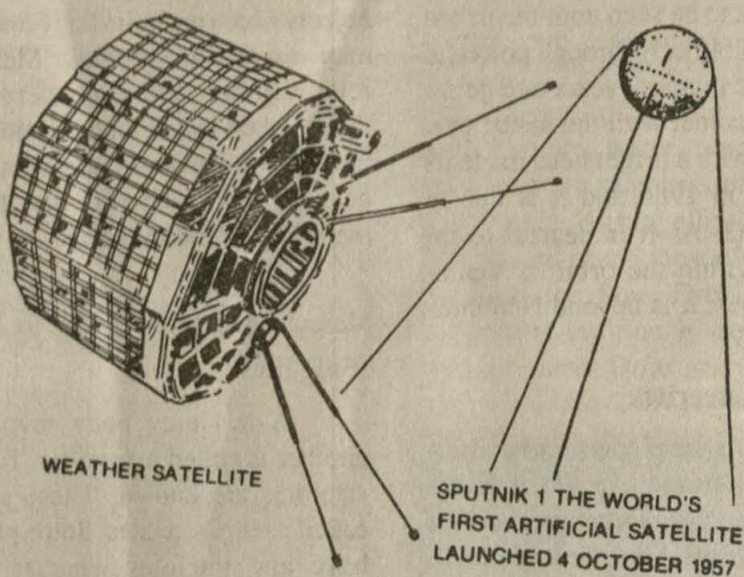


Fig. 13.16

Indian Satellites are : BHASKARA I, BHASKARA II, APPLE, INSAT—IA, INSAT—IB, ROHINI, IRS—IA.

All these artificial satellites will ultimately burn like meteors. Artificially satellites may be seen travelling across the sky either just before sunrise or just after sunset.

Some of the uses of artificial satellites are :

- (1) Weather forecasting
- (2) Television and radio transmission
- (3) Communication
- (4) Improvement of agricultural production
- (5) Locating mineral resources
- (6) Knowing more about space.

SUMMARY

1. Before glancing at the sky, the observer must sit in a relaxed position without looking at bright lights so that his eyes may get accustomed to seeing in darkness. The observer may watch the sky fixing any reference mark.
2. An ordinary observer can distinguish without a telescope on a good night an average number of about 3000 stars. The total number of stars in the entire sky which could be seen with the naked eye is between 5000 and 6000.
3. It is convenient to imagine that the stars are points on a huge sphere called the celestial sphere, with the earth at the centre. This imaginary sphere appears to rotate round the earth from east to west.

4. Distances between heavenly bodies are measured in the unit of *light year*.
5. All the objects in the universe are in continuous motion.
6. A group (or cluster) of stars that form a pattern in the sky is called a constellation.
7. Some of the north polar constellations are : Ursa Major (Great Bear or Saptarishi); Ursa Minor (Little Bear or Dhruva Matsya) ; Draco (Dragon or Kaleya) ; Cepheus, Cassiopeia (Samishtha). Auriga (Charioteer, or Sarathi), Orion, Cygnus (Swan or Hansa) ; Lyra (Svara--Mandala).
8. Star is a ball or very hot glowing gases which creates energy and gives it out mainly in the form of light. The stars appear to be twinkling whereas the planets do not.
9. A star that happens to lie very close to the celestial north pole (that is the position where the axis of rotation of the earth cuts the celestial sphere) is known as *Pole Star*, the 'Dhruva Tara'. It is almost exactly over the north pole of the earth so it seems to stand still as the earth spins. Pole star is a pointer to the north and is known as sailor's star.
10. One of the easiest way to find the Pole Star is to locate the constellation Ursa Major or Great Bear. Look along the seven bright stars that form the ladle shape (or a kite with a thread). The last two of these stars point directly to the Pole Star.
11. A planet is a body circling a star. Some of those circling the sun are rocky and others are liquid and gas. Planets have no light of their own, but reflect sunlight.
12. Our solar system has nine planets, asteroids, comets and meteors. Planets revolve round the sun in the same direction and very nearly in the same plane.
13. Comets are icy bodies (or directly snowballs) that circle the sun. They form long glowing tails when they come near the sun.
Halley's comet with a bright head made its last appearance in 1986 and it is due to reappear in 2062.
14. Meteors are shooting stars. They are stony or metallic bodies, mostly of very small size, which become visible when they travel through the earth's atmosphere. Due to friction of air, they heat up to very high temperature and are completely vaporized before they can reach the ground.
15. A large meteor that does not completely vaporize and actually reaches the earth's surface is called a meteorite.
16. Satellite is an artificial or natural object that circles another body.
17. The sun is also a star. It is the nearest star to the earth.
18. There are millions of galaxies in the space. The sun is one of the stars in our Milky Way.

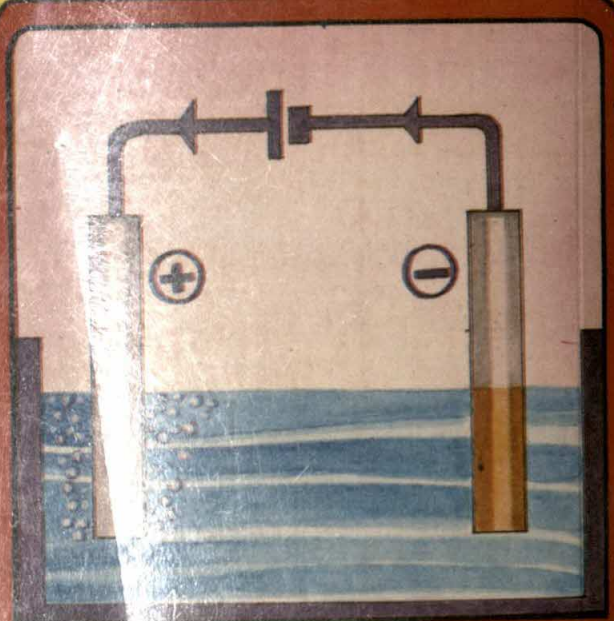
QUESTIONS

1. What is Celestial Sphere?
2. Which way do the stars seem to spin, clockwise or anticlockwise ? Which star is nearest to the point about which they spin ? Why do the stars appear to move in this direction?

3. What are constellations ? Name four north polar constellations.
4. What distinguishes Ursa Major from Ursa Minor ? Which one is called 'Saptarishi'?
5. Name the constellation
 - (i). that is shaped like a 'W' and depicts a queen seated on her throne.
 - (ii). that contains the yellow star capella.
 - (iii). that is known as the northern cross and the Milky Way runs through the constellation.
 - (iv). that forms a shape similar to the plough or a kite with a thread tied at one corner.
 - (v). that is easily recognised by the three stars that lie close to each other in a line.
6. (a) What is a Pole Star or a 'Dhruva Tara' ?
 (b) Name the Greek word from which the word 'pole' is derived. What does that word mean ?
7. Why is Pole Star called the 'pivot' of the axis of rotation ?
8. What distinguishes Pole Star from other stars ? Where is it located in the sky ? Why is it called sailor's star ?
9. Mention, step by step, the process you would follow to identify the Pole Star in the sky.
10. (a) What are planets ? Why are they called "wanderers" ?
 (b) How are planets distinguished from stars ? Mention at least three points.
11. (a) Name the various planets in our solar system.
 (b) How many planets in our solar system can be clearly visible to the naked eye ?
 (c) Name the planet which is seen as the brightest object (leaving out the moon) in the night sky. When is it known as the evening star ?
 (d) Which is the smallest planet in our solar system ?
 (e) Name the planet which appears a little reddish in the night sky ?
 (f) Name the planet situated closest to the sun.
12. What is a comet ? When does it begin to have tail ? In which direction does the tail of the comet point ?
 Name the prominent comet that was seen in early 1986. (A.I.S.E. 1981)
13. (a) What is a meteor ? When is it called a meteorite ?
 (b) Can a meteor reach the earth's surface ?
14. (a) What is an artificial satellite ? Can we call the moon of the earth an artificial satellite ?
 (b) Name the first artificial satellite and two other satellites put in orbit by India that are still revolving round the earth.

- (c) What ultimately does happen to an artificial satellite ?
- (d) What is the difference between a planet and a satellite ?
15. Classify the following under the heads :
 Star; planet ; constellation and 'satellite'.
 Mars; Sirius; Pole Star; Pluto ; Great Bear; Saturn; the Moon; Orion; the Earth;
 the Sun; Aryabhata; Draco, ROHINI, INSAT-IA.
16. (a) What is a planetarium ? Name two cities in India which have planetaria.
 (b) Name cities in India which have huge astronomical observatories. Who got these
 observatories built ? Why are these observatories not much in use these days ?
 (c) Name a monthly journal of the CSIR, New Delhi which publishes the night sky
 maps.
17. Why does not the moon twinkle like stars ?
18. Many stars are much larger than the Sun. Why do these appear much smaller than
 the Sun ?
19. A star is a eight light years away from the earth. What does it mean ?
20. What is a galaxy ? Is Milky Way a galaxy ?
21. Why is the distance between stars expressed in light years ?
22. What is a light year ?
23. What is a solar system ? Name the largest planet of the solar system.
24. Draw the shapes of the following constellations showing the positions of their stars:
 (i) Ursa Major (ii) Orion.
25. Mention three uses of an artificial satellite.
26. Name two objects other than planets, which are members of the solar system.
27. How much time does the earth take to complete one rotation on its own axis and one
 revolution around the Sun ?
28. State two differences between a star and a planet.
29. Choose the most appropriate answer for the following statements :
- (i) The nearest planet of the solar system is :
 (a) Pluto (b) Saturn (c) Earth (d) Mars (e) Jupiter.
- (ii) A group of stars forming a definite pattern is called a
 (a) galaxy (b) constellation (c) solar system (d) universe
- (iii) The streak of light caused by a meteoroid burning through the atmosphere is called
 a :
 (a) planet (b) asteroid (c) satellite (d) comet (e) shooting star (f) meteorite

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